THE

ELECTRICAL REVIEW.

VOL. LVI. APRIL 28, 1905. No. 1,431.

ELECTRICAL REVIEW.

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THE

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ARE LIGHTNING CONDUCTORS A SOURCE OF DANGER?

THE reports published from time to time by the Lightning Research Committee form very entertaining reading, and serve to show how very little we have yet advanced in the direction of rendering buildings immune from injury due to lightning flash.

As we cannot prevent lightning, the efforts of experts have been hitherto directed towards studying its character and effects, and to attempting to control its flight or passage by providing a directive path by means of lightning conductors, rods, aigrettes and other accessory details.

But we are never quite sure whether or not, in providing such a path, more harm than good may not be done. A building "protected" by a lightning conductor is probably more often struck by lightning than it would be without it; and unless the conductor offers a sufficiently clear run direct to earth, there is the danger of side flash, when a portion of the discharge will pass through the masonry or metal work of the building to earth.

It is a little discouraging and disconcerting to read in the reports referred to that a country house which, during its 30 years' existence without a lightning conductor, had never been struck, was, after being "protected" by means of a conductor, very shortly afterwards struck and severely damaged. This is by no means an isolated case, and it is noteworthy that in most of the instances recorded, lightning conductors were attached to the buildings.

One of the latest object lessons occurred on April 1st—of all days most suggestive—when, during a severe thunderstorm, the Second Pyramid of Egypt was struck, several great blocks of masonry being dislodged from the summit and hurled to the ground.

This is said to be the first instance within living memory of any of the Pyramids having been struck by lightning, "which is all the more remarkable, seeing that all the Pyramids are provided with conductors," says the *Pall Mall* correspondent. It was too bad of the *Pall Mall Gazette* to blurt out the naked truth like that, but perhaps the correspondent did not quite mean it in that way. At any rate, the Pyramids seemed to have managed very nicely without lightning "protection" for about 5,000 years.

A week or so ago St. Matthias' Church in Richmond was struck by what has been described as a fireball. This is a form of lightning about which there is a certain amount of scepticism.

According to the published accounts, a blinding flash of lightning was seen, and people saw "a huge ball of fire descending from the clouds. It exploded with a loud report near the church steeple, and the concussion was so violent that pedestrians were thrown to the ground, windows and doors loudly rattled, and the effects were felt across the river as far as St. Margaret's."

Considerable damage was done to the roof of the church, electric light wires were fused, and the glass fronts of distributing boxes were broken.

There is an element of mystery about this ball lightning. Is it not possible that the lightning flash did the damage, and the fireball was a mass of the molten metal from the lead roof which was damaged?

It will be interesting to learn something as to the condition of the lightning conductor, especially as to the condition and efficiency of its earth connection, and whether it was useful or otherwise in protecting the building.

Experience appears to teach that the safest way to protect a building from lightning is to keep the conductor quite clear of the building, that is to say, sufficiently far from it absolutely to prevent side flash. If this be so, the best way to treat an isolated building, such, for example, as a country house, would be to erect a conductor in the form of a tall steel mast, or a wood mast fitted with an efficiently earthed copper conductor, at a safe distance.

While on the subject of lightning flashes, we may draw attention to the accident described in our "Telephone Notes" to-day, which aptly illustrates the dangers pointed out in the article by Mr. Frank Broadbent, published in our last issue.

HIGH FREQUENCY CURRENTS.

An inquest held at Westminster on 15th inst., has lately been reported in the daily Press, in more or less sensational terms. "Death after a light bath," "Death under electric treatment," "Death after electric treatment," are some of the headings under which the facts of this case have been set forth. It appears that the Hon. Alice Monck, aged 52, lately of Rostrevor Road, Fulham, had been attending the electrical department of Charing Cross Hospital, suffering from "Gout in the left arm." Between March 13th and March 30th, she had five light baths, which, however, "did not suit her very well." She then "began the High Frequency Treatment and seemed to get much better." But on April 11th, when the electricity had been applied for half a minute, "her face began to perspire," and the current was therefore cut off. Death took place shortly afterwards. It would thus appear that, an interval of eleven days having elapsed since the light bath was given, this part of the treatment at least must be exonerated from having had any close connection with the fatal issue. If the latter was in any way due to the medical treatment, the cause is obviously to be sought in the high frequency current. It is, therefore, with a sense of much relief that we find that the medical man in charge of the electrical department and Dr. Freyberger, who found by *post-mortem* examination that cerebral hæmorrhage was the immediate cause of death, were able to express the opinion that this was a "coincidence," and not attributable to electric treatment. Nevertheless, the occasion may be made use of to call attention once more to the very considerable responsibility that attaches to the use of high frequency currents, and again to disabuse the public mind of the mistaken and very mischievous notion that if such treatment "can do no good, it can, at least, do no harm." It is quite certain that high frequency currents have a very considerable, and probably a by no means uniform influence upon vasomotor nerves, and upon blood pressure. By experiments on rabbits, it has been shown that when the current is passing, the blood vessels of the ear rapidly dilate (as would occur after section of the sympathetic nerve), and that this is followed by a marked contraction of the same vessels. Further, it is well known that in the human subject, in consequence of this same vasomotor action, there is increased activity of the blood vessels of the skin, followed by sweating. It is clear that such changes in the condition of the capillaries must produce modifications of blood pressure. A slight incision into a rabbit's foot will show an increased activity of the circulation when the current begins to flow. Both the manometer, in the case of experimental animals, and the sphygmograph in man have demonstrated the very important changes in blood pressure that occur when high frequency currents are passing through the body.

In connection with this case there is the further point of some interest, although of infinitely less importance, that a lady of title should be attending the electrical department of a public hospital. According to one account, it was stated by Dr. Bruce at the inquest that in this instance the lady in question had been recommended to go there by a firm of solicitors. If this be so, we can only hope that the lawyer who sends his clients for presumably gratuitous medical treatment does not forget to follow the same benevolent course of action when it comes to the question of his own costs.

THE USE AND ABUSE OF FUSES ON TRAMCARS.

A writer in the March number of the *Street Railway Journal* goes to considerable pains to prove that the utility of the fuse has not been acknowledged sufficiently by tramway men. The reason is not far to seek. Both in America and in Europe, the fuse has been abused out of existence. It exists in name on most cars, although many have been turned out of the works without any provision in that way, however nominal. Every motorman knows where to look for the fuse on his car, for the teaching of its position survives as a custom. Some of them even remember how to replace it, if some accident should cause it to blow; but for all the use it is on most cars, it might just as well not be there.

In early days the fuse was the sole safety device, and that fact may have accounted for a goodly number of the "burn-outs," to use a colloquialism; but it has been superseded more and more as automatic circuit-breakers were perfected, until, at the present day it exists, just as the "os coccyx" or the appendix exist, as a part of the equipment of a car which has degenerated until it serves simply as a connecting link.

The circuit-breaker has become the primary safety device, because it is certain in action, instantaneous, and easily adjusted to suit varying conditions. It is, moreover, amenable to a simple test for accuracy which does not involve destruction.

Now a fuse, as hitherto known to the tramway portion of the electrical fraternity, has had none of these qualities. It has been most uncertain in action; it has acted instantaneously only when proportioned too scantily for continuous operation under normal conditions; it has not lent itself to accurate adjustment to any desired carrying or fusing capacity, and a test of its fusing capabilities necessarily involves destruction.

But the question we have to ask ourselves is this:—Is the blame of these defects to be piled wholly on the fuse, or must we take any of it?

The answer is clear to anyone who is acquainted with the minutiæ of tramway working: The fuse has not been handled either respectfully or intelligently. If any great need for it had been felt, we may be sure that such an answer could not have been made, so it is safe to say, in a general way, that it has not been wanted.

Tramway engineers are not all as bad as the motorman who attributed the slowness of his car to a weak fuse, but a number of them have not given sufficient thought to the advantages which a *suitable* fuse might offer, however perfect the car circuit-breaker may be.

To be of any use at all, the circuit-breaker must be set to open at a current which is anything from 50 per cent. to 200 per cent. above the average current taken by the motors. The correct setting will depend entirely on local conditions and on the equipment. Its use is limited, therefore, to protecting the power station, line, and car from the effects of a continued short circuit; but as the author of the article under review points out, some provision ought to be made for continued overloading of the motors somewhere between the limit point of rapid deterioration and the limit at which the circuit-breaker is set. That is where the humble and much-maligned fuse would come in. Carrying momentarily a current in excess of that at which the circuit-breaker is brought into action, it will give the honour to the latter on short-circuits, but it may be designed to open the circuit if for any reason—and there are many—the motors have been loaded beyond their rating for any length of time.

In such a case the circuit-breaker would not act until the heating effect of the overload had brought about a total failure of part of the equipment.

In consequence of the neglect of the fuse, the type used on tramcars has not improved, and will not fulfil our requirements; but the design of fuses for other branches of electrical work has not stood still, and something suitable in every respect as a companion to the circuit-breaker can be discovered by anyone who cares to set about the quest.

Such excellent papers as that of Prof. Schwartz and Mr. W. H. N. James, of which an abstract is given elsewhere in this issue, will contribute more than any other agency to the improvement and development of fuses as accurate and reliable safeguards to electric circuits.

It is essential that they shall be accurately standardised and dependable, that they shall be completely enclosed and watertight, and above all, that it shall be next to impossible for an anxious motorman to "strengthen" them.

In any event a fuse of some kind ought to form part of the circuit of every car, if only to act as a standby to the circuit-breaker; for even when systematic and constant attention is given to these things they may "turn nasty" on occasion; and, while motormen have the use of their hands, it is possible for a circuit-breaker to be held in "to stop it blowing," even though the penalty be boiling in oil.

Technical Instruction in Germany.

Owing to the appointment of Dr. Rose, H.B.M. Consul in Stuttgart, to the post of Assistant Educational Adviser to the London County Council, the extremely valuable series of reports he has written upon the methods of imparting technical instruction in Germany has come, at least temporarily, to an end. The pamphlet now before us is No. 630 in the Miscellaneous Series of the Diplomatic and Consular Reports, is the 21st of Dr. Rose's reports, and is of a supplementary and heterogeneous character. It deals with all the technical schools omitted from previous reports to the number of 180, and it gives details relating to several representative institutions, none of which (this time) is immediately or solely devoted to our branch of industry. Nevertheless, the report is most interesting to study, for three features of the German methods stand out so clearly. In the first place, there appears to be a specialised training place for the member of every conceivable handicraft, even toy-makers, inn-keepers and wig-makers. In the second place, the instruction given seems as minute in theory as in practice, and exhaustive in its inclusion of allied or subsidiary subjects. In the third place, the schools appear to be popular, and to be much believed in by the trades they attempt to foster. In some, the instruction is free to Germans, or to such as belong to the neighbourhood; in others there is a fee charged, which is doubled in the case of foreign students.

The technical school of tanning at Freiberg in Saxony is dealt with at length by Dr. Rose, and may serve as an example of the rest. The pupils must be 17 years old, and must either have practical knowledge of tanning, or must enter the attached tannery. The fee is £10 for the practical work (when needed), £10 for the theoretical instruction, and 30s. for the use of the laboratory. Foreigners pay double. The school was founded in 1889, is not self-supporting, but receives annually £250 from the Government, £125 from the town, and £200 from the leather industry of the district. In 1903 there were 76 students, 42 of them being foreigners, who came from most countries of Europe (not the United Kingdom), from Chili and Japan.

In addition to the obvious subjects of instruction, are free-hand and geometrical drawing, commercial book-keeping, the laws and customs of exchange, credit, banking, bills, and other branches of political economy, business correspondence, calculations in English money, and the like—in fact, practically everything needed for the equipment of a foreman tanner or a merchant prince. In many of the schools much attention is devoted to those aspects of statute law with which the foreman, manager, or even employé of a factory or workshop may come into contact: to old age or ill-health insurance, to what we should term the Factory Act, the Employers' Liability Act, the Compensation Act, the Truck Act, &c., and, where desirable, to the various enactments relating to mines and mining.

It is, no doubt, possible to view this general question of technical instruction on German lines in a far less favourable light than that in which Dr. Rose presents it to us; but if, in his new position, he is able to introduce the spirit into this country without all the details—the spirit of belief in education and specialised knowledge—he will do no inconsiderable service to us all.

Apprentices.

Writing on the apprentice system in America, Mr. Carlton, in *Cassier's Magazine*, refers to the two sources whence the United States draw their skilled men. One source is the small shop, the other is Europe. The small shop has always been the best training ground for sound and skilful men in every country, but it is dying out or at least becoming much reduced in number, and Europe is drying up also as a source of skilled men, though many of the foremen and skilled workmen in the United States are English or Swedes or Germans. It is a matter of common remark in Europe that the American workman, as a rule, however good as a machine man, is not much good as a handicraftsman. He can run a machine and is full of artfulness in the tricks he will make it perform, but away from that machine he is about as helpless as a liner with a twisted tail shaft. The future of the engineering industry demands men, and the question of apprentices is now as much a live question in America as it is here. It is necessary that a certain ratio of boys should be kept in every shop to make up wastage by death, retirement or other lapsing and trade expansion. This ratio Mr. Carlton puts at 1 to 5, or even 1 to 4½, and he argues for a general and adequate system of apprentices in order that a proper supply of reasonably competent workmen shall be maintained. At present the machinist in the United States appears to graduate, as the Americans term it, from some sort of a trade school or a night school. The difficulty always experienced by boys is the tendency to keep them too long at one machine, doing work for, perhaps, months that can be fully mastered in a few days. So much machine work is so entirely devoid of skill on the part of the attendant that the future workman cannot hope to be on a par with the old handicraftsman. His trade will find him a living, but the exercise of his intellect must find some other satisfaction. So long as work is done on manufacturing lines, it is useless to blink the fact that the future holds but little employment except for the mere machine attendant.

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AN ELECTRICAL REVIEW OF THE LOUISIANA PURCHASE EXPOSITION OF 1904.

By R. BORLASE MATTHEWS, Wh.Ex., A.M.I.C.E.

(*Continued from page* 317.)

A UNIQUE feature of the Intramural Railway power plant was a 160-H.P. Doble high-pressure tangential water turbine, running at 700 r.p.m., direct connected to a 100-KW. generator. The side of the wheel and the discharge pit were covered with plate glass, so that the action of the water could be followed. It was controlled by a Lombard governor, which not only regulates the speed, but also prevents any shock in the supply pipe due to water hammer, by opening a by-pass, and thus avoids changing the velocity of the water too quickly. As of course a sufficient head could not be obtained on the Exposition grounds, a triple expansion condensing pump was used to supply the necessary water at a pressure of 300 lb. per sq. in. This type of turbine is that which is now so largely used on the Pacific Coast.

The spectacular effects of the illumination of the Exposition were very successful, especially when the magnitude of the scheme was considered, for the grounds—1 mile wide and 2 miles in length—had to be made conspicuous by the illuminations at night. Incandescent electric lamps were used throughout for this purpose, requiring a total of half a million 8-C.P. lamps, having clear, ruby and emerald-tinted bulbs. The current supply was from a three-phase system,

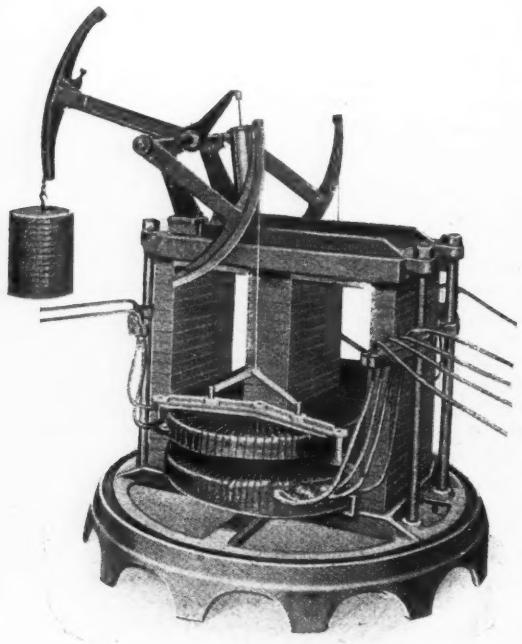


FIG. 9.

separate feeders extending to each colour of light with a common neutral for all three, and water rheostats being arranged in each circuit, so that the effect of the lights gradually increasing in brilliancy up to full power could be obtained.

No arc lamps were used for decorative lighting, but some 2,000 were employed to light the interior of the buildings, the 7 miles of stockade enclosing the grounds and the Pike. The system adopted was a series-alternating-current enclosed arc lamp system, operating at 60 cycles and 2,800 volts. The current supply was from a 600-KW. Stanley inductor alternator driven by a Willans engine, constructed by C. H. Bradley, jun., & Co., of Pittsburg.

The regulating device of the arc light system was a constant-current G.E.C. air blast transformer, having its primary winding connected directly to the 2,300-volt alternator. This apparatus is shown in fig. 9. There were 18 of these transformers installed in the Machinery Hall, each provided with a separate switchboard panel equipped with the necessary controlling and measuring apparatus. The capacity of each transformer was 62 KW., and they were each capable of supplying 100 arc lamps taking a constant current of 6·6 amperes.

The lamps operated on the differential system with shunt and series solenoids, which moved two laminated armatures connected through a lever to a carbon clutch. The shunt and series windings were in opposition, tending to oppose any change in the arc pressure. Adjustment for the impressed pressure was made by means of a sliding weight; this assisted the series coils in striking the arc at the proper pressure. A small starting resistance was provided, and a mechanical cut-out arranged to operate in case of an open circuit in the lamp. Vibrations of the armature core due to the alternating current were absorbed by a small leaf spring in each armature. Each of these lamps took 6·6 amperes at 72 volts.

On account of the saving of labour in trimming, enclosed arc lamps seem to be used in America almost without exception.

A novel arc lamp exhibited was that of Dr. Steinmetz. This was a luminous or flaming arc, produced between magnetite poles or magnetite and copper poles. This lamp has a very marked increase in efficiency over the carbon-burning lamps, and seems to be especially suitable for street lighting.

Dr. Steinmetz has shown that magnetite electrodes and the mercury arc stream both act as rectifiers of alternating current under certain conditions. One of his mercury rectifiers on a single-phase alternating current circuit was shown in operation by the General Electric Co., transforming alternating current to continuous current, having for a load a 7½ H.P. continuous current motor. It will be remembered that it was only a short time ago that a mercury arc rectifier was not considered practicable except on a three-phase system.

The Cooper-Hewitt lamp was a very prominent feature of the lighting exhibits, being used to illuminate the Westinghouse Co.'s stands, and also by the official photographers. Owing to their exceptional photographically actinic properties, a large field seems open for the use of these lamps, in this particular direction. They are, however, too rich in violet rays and lacking in red rays to be of much use for any other purpose at present, unless screened and shown with a light having an excess of red rays. The Westinghouse Co. gave daily exhibitions, in a theatre they had erected for the purpose, of cinematograph views of the interiors of several of their factories at Pittsburg, taken with the Cooper-Hewitt lamp. These were the first successful attempts to photograph interiors at the rapid rate required for a cinematograph film, thus showing the value of the new lamp.

A mercury vapour lamp invented by Dr. Steinmetz was also shown. This lamp had incorporated in it several important practical modifications. There was no need to tilt or incline it to strike the arc, as a conductor came down the centre of the vertical tube, which came in contact with the mercury in a cup at the bottom. In the base was an iron core, which, when a current passed through a coil placed beneath the cup, drew the cup down, causing the mercury to fall away and break the contact with the conductor, thus automatically starting the mercury arc.

Some 6,000 Nernst lamps were used for the illumination of the Art Gallery. These lamps have, of course, been wonderfully developed since the Paris Exposition. In America the trend of the development has been in the direction of lamps for alternating current circuits, and with multiple glowers, having independent or overhead heaters.

The exhibit of a radiophone or wireless telephone transmitting and receiving station, made jointly by the American Telephone & Telegraph Co. and the General Electric Co., attracted a good deal of attention. The radiophone is a combination of an arc light, reflectors, and a selenium cell. By these means speech was transmitted to distant points without the use of wires or other such intervening medium, the transmission taking place by light furnished by the arc, and projected in a slender beam by a parabolic reflector.

In the court of the Electricity Building another wireless telephone system was shown. Around the court a circuit of wires connected to a transmitting station was arranged. In the transmitting station a receiver was placed in front of a phonograph, and upon taking up a position in the court and placing a receiver, connected to a small coil carried in the hand, to the ear, the phonograph could be heard distinctly, no sound being audible without the receiver. A somewhat similar principle has, of course, been used for detecting faults in alternating current mains in England.

The De Forest Wireless Telegraph Co. had a very extensive exhibit of their apparatus, including a 300 ft. tower and a 250-ft. mast for sending commercial messages to Springfield, Kansas and Chicago. Smaller exhibits were made by Marconi and Ducretet.

In telephone work the great advance was in the automatic exchange system, in which three or four rotations of a dial on the caller's instrument secure instantaneous and direct communication with the number required, there being no intervention of an operator at an exchange. Some half-dozen of these exchanges are now in operation at Chicago, Fall River, New Bedford, &c., and are giving every satisfaction.

As at present developed, this system has taken a step backward by re-introducing the local battery; though the disadvantage is not so great as it used to be, owing to the great improvement in dry batteries. In any case, it is within the bounds of possibility that in this system the local battery will be abolished eventually. A poor engineering feature of the system also is the automatic apparatus at the subscriber's station; and probably maintenance will be higher. Depreciation should be taken at about the same value as for the manual system, since much of the depreciation in telephone apparatus is due to the introduction of new inventions. In trunking between two offices there seems to be little difference between either system. Since the automatic system is in its infancy, and yet has done so much, it is to be anticipated that very great improvements will yet be made. Apart from the engineering features, it may meet with such popular approval as to compel its universal introduction.

Another novel exhibit in the Court was of some apparatus used for the purification of drinking water by electrolysis. The success of the apparatus was due to the choice of aluminium electrodes, the action being to produce aluminium hydroxide, which, as has long been known, combines chemically with most of the organic matter in impure water. The suspended aluminum hydroxide also mechanically entangles the bacteria and fungi present, as well as any solid particles. The resulting milky fluid is then filtered by passing it through a bed of crushed quartz. Analyses show that the free ammonia is increased, owing to the electrolytic action on the dangerous albumenoid ammonia, the latter being reduced to a minimum.

The hydrogen and oxygen evolved are partially dissolved in the water, since the latter is under the pressure of the supply mains. No change seems to be made in the chlorine, but the temporary hardness due to bicarbonate of calcium is nearly all removed.

The application of a continuous current of 20 amperes at 15 volts is stated to be sufficient to purify 500 gallons of water that is ordinarily undrinkable, and as the water supply at St. Louis, taken from the Mississippi River, is notoriously bad in quality, the exhibitors had excellent material at hand to illustrate the advantages of their apparatus.

In storage batteries the principal novelty was the introduction of fibrous partitions or screens between the positive and negative plates, to avoid the troubles occasioned by short circuits due to the paste falling out of the plates.

Good voltage regulation is an important factor in an electric supply system, but not a thing that is easily attained. The Terrill automatic voltage regulator shown by the General Electric Co. was therefore of special interest. Two types of the apparatus, which is suitable for mounting on a switchboard, are made, the one for D.C. and the other for A.C. circuit voltage regulation. The direct current apparatus for the smaller sizes of generator works on the principle of rapidly opening and closing a shunt circuit across the generator field rheostat, while the alternating current device operates by opening and closing a shunt circuit across the exciter field rheostat or rheostats, thus keeping the exciter voltage at the point necessary for the maintenance of constant voltage at the bus-bars or centre of distribution. Should the regulator be applied on continuous current generators having a larger capacity than 125 KW., the fields must be separately excited like that of an alternator.

(To be continued.)

ELECTRICAL REPAIRS AT SEA.

[COMMUNICATED.]

THE applications of electricity in the Navy are so many and varied in their nature, and the conditions under which repairs and the accompanying tests have to be carried out often so adverse, that in many cases ordinary shore-going methods are in a great measure inapplicable. Consequently it is very often that makeshifts have to be resorted to and rough tests applied, which would appear strange to those who are accustomed to work in the ordinary lines of every-day life.

To begin with, a man-of-war carries a certain fixed proportion of stores, instruments and spare gear based upon the average demands as they have been represented in time past, and anything that is required outside these limits must be supplied by the ingenuity, craftiness or liberality of the torpedo lieutenant in charge of the ship's installation. Moreover, the Admiralty are comparatively slow to move in the matter of latest improvements, and will not accept innovations, as a rule, until they have undergone lengthy and convincing tests, so that often where an instrument has been very obviously improved a considerable time elapses before it is adopted.

Owing to the use of electricity in the big guns and explosives generally, it is essential that there should be no possibility of tests being carried out with instruments capable of giving sufficient current, under any circumstances, to bring in an element of danger.

The two principal instruments which are supplied for all ordinary testing use the form of gravity Daniell cell known as the Minotto sawdust battery.

These instruments have been described in former articles in detail, and it will be sufficient here to remind our readers that one known as the single-cell test battery consists of a low-resistance detector mounted on a single cell, while the other consists of six smaller cells in a box with a high resistance astatic detector joined up so that any number of cells from one to six can be put in circuit by shifting a plug.

As a matter of fact, these detectors are both known in the Navy as galvanometers, and are distinguished by their approximate resistances, which are respectively 20 and 1,000 ohms, but they can hardly be regarded as measuring instruments as they are not calibrated, and the magnetic saturation of the needles is liable to vary considerably. The single-cell instrument is used for detecting continuity in a circuit by giving a pronounced swing, and it is capable of showing as low a conductance as 1,000 ohms, roughly speaking, the deflection then being only just distinctly perceptible; the cell has an average internal resistance of 50 ohms, which with the detector in circuit is brought up to 70 ohms, and therefore it can never give a greater current than about one-seventieth of an ampere, or less than one-hundredth of that required to fire the ordinary naval fuse used for explosions. The six-cell test battery is used for detecting faults in insulation, and may be relied on to discover faults of the order of 40,000 ohms. With this instrument, which is used for all ordinary tests, the operator is satisfied if he can detect no movement of the needle when the key is pressed.

Both instruments are in a very portable and convenient form, and are capable of standing a great deal of rough handling. Their utility, however, does not end here, for a good deal of measuring and comparison work can be done with each of them.

Every ship carries a large number of cells of the Leclanché type for gun circuits, bells, telephones, and all manner of open circuit work, and it is necessary to test these cells continually to see that they are in good working order, and

capable of giving the full current required. The test that is laid down for these cells is based upon their capability of fusing a certain length of platinum-silver wire equal to that in an ordinary gun fuse, through a specified resistance. The process of testing in this way with the instrument supplied for the purpose is exceedingly tedious in practice, and the torpedo lieutenant has other things to do besides spending the best part of his life testing batteries; consequently he is often tempted to make a short cut with that invaluable instrument the single-cell test battery.

The method employed would be somewhat as follows:—A cell is chosen which is expected to be in good condition, and the service test is carefully carried out with it by fusing platinum-silver wire.

If it gives a satisfactory test, it is put aside while the detector of the test battery is shunted by a moderate length of low-resistance wire; the Daniell cell of the instrument will not be used, and is disconnected. The shunt wire is now adjusted by trial until the detector gives a convenient deflection when the particular cell under test is joined to its terminals, and the deflection is noted. Now it is obvious that any other cell which will give the same deflection when momentarily joined up to the detector is in as good condition as the cell first tested. The arrangement can very easily be carried about, and the test applied to all the cells in the ship. Those which are at all doubtful can be removed and tested in detail at leisure.

Another use to which the single-cell test battery may be put, and which is useful in measuring voltage, is as a standard in conjunction with an improvised potentiometer. In this case the cell is taken as giving 1·04 volts, and moderate voltages can be compared on an ordinary black-lead pencil split in two, with divisions marked off on the wood in which the carbon lies. Care, of course, must be taken to see that the lead is not broken.

The way in which such a potentiometer is made is as follows:—

A really good drawing pencil is taken and soaked in water; the glue is thus softened, and the half which has not got the plumbago embedded in it comes away fairly easily.

The remainder of the pencil is now carefully dried; a couple of notches cut close to either end are then made in the wood, and a binding of copper wire wound into them so as to make good contact with the plumbago. The ends of these copper bindings can either be used as leads themselves, or have flexible leads soldered to them. The slider consists of a piece of similar wire taken once round the pencil and twisted to its own part rather tightly, so as to make a fair contact with the core of the pencil.

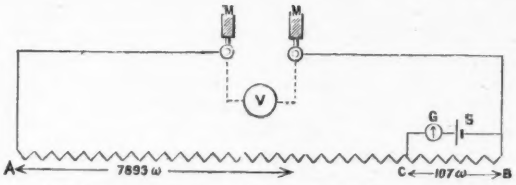
The arrangement is now tested by marking a half-way point and putting the slider on to it.

Two test cells from the test battery are connected to the ends, and the slider with the sensitive detector and a single cell joined in series connected to one of the ends so as to reduce the difference of potential; if the instrument is properly constructed the galvanometer needle will not be deflected. The slider is then moved until a perceptible deflection is noted, which shows the minimum scale that may be used. The wood surface is now divided off into a suitable scale, and the potentiometer is constructed.

This little device, it must be remembered, can be carried about in the pocket, and applied in all sorts of holes and corners, and therein lies its virtue; the six-cell test battery, taking the difference of potential of each cell as 1·07, gives with all the cells in series 6·42 volts, while the voltage most common on boardship is from 80 to 100, hence no very material error need be expected even in testing the lighting mains, and where batteries for the firing circuits are suspected of giving a low voltage, the results are proportionately accurate.

The batteries are used in sets of three, six or ten cells, according to the kind of gun they are used for, and therefore in order to quickly test all the batteries on the upper deck after, say, a night attack by torpedo boats, when in consequence of sustained firing a considerable strain has been put on them, and another attack is expected shortly, it is easy to apply the potentiometer to the terminals of each in turn, without disconnecting anything, and detect at once any that seem likely to run down. The slider, being set once for this type of battery, need not be shifted, the deflection of the galvanometer showing at once if they are above or below the standard fixed, by its deflection either way.

There is another method in which the potentiometer principle is used, however, which is applied for verifying or recalibrating a voltmeter at sea, the necessity for which is by no means unlikely to occur after heavy gun practice, when the interiors of most instruments are shaken out of the monotony of ordinary routine, and it is not infrequently the fate of the moving parts to be replaced by the delicate finger and thumb of a burly autocrat of the dynamo room. For such work as the calibration of a voltmeter, a freshly-built Minotto is used as a standard, and it is placed in circuit with a resistance box, in which 107 ohms have been unplugged; this box in conjunction with a Wheatstone bridge forms the potentiometer, and by altering the resistance in the Wheatstone bridge the ratios are adjusted. A reference to fig. 1 shows the principle. Imagine the dynamo to be maintaining a difference of potential



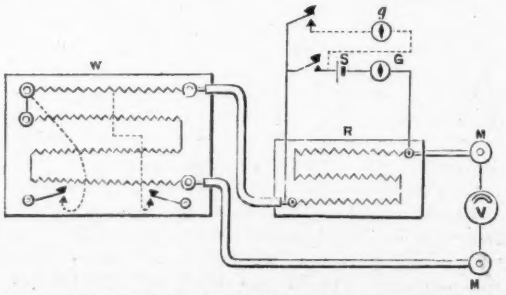
A C, Adjustable resistance; C B, Permanent resistance; V, Voltmeter; M M, Dynamo mains; G, Galvanometer; S, Standard cell.

Fig. 1.

of exactly 80 volts, and let the terminals be connected up to a resistance of 8,000 ohms; then there will be a potential fall of 1 volt for every 100 ohms of the resistance, one-tenth of a volt for every 10 ohms, and one-hundreth of a volt for every ohm.

A B is a resistance of 8,000 ohms, A C is the resistance unplugged in the Wheatstone bridge, C B is the 107 ohms we have already spoken of, consequently 7,893 ohms will have to be unplugged in the Wheatstone bridge, and this is represented in the figure by A C. Now, if our standard cell gave exactly 1 volt the matter would be "plain sailing," there would be no need for the odd 7 ohms unplugged in the resistance-box and the uneven number in the Wheatstone bridge, for these two numbers would be 100 ohms and 7,900 ohms respectively; but we have to encroach upon A C to the extent of 7 ohms, in consequence of our standard cell giving seven-hundredths of a volt more than unity, and it is for this reason that the odd numbers appear in our resistances.

The actual manner in which the instruments are joined up is shown diagrammatically in fig. 2, and it is usual to join a high resistance galvanometer or detector round the key



W, Wheatstone bridge used as a high resistance box; R, Permanent resistance 107 ω; V, Voltmeter; S, Minotto-Daniell cell with low resistance galvo. G; g, High resistance alternative galvo.; M M, Dynamo mains.

Fig. 2.

to avoid sending a large current through the test cell before the balance is obtained or nearly obtained. This is shown in dotted lines.

By this means the potential difference between the dynamo mains can be balanced for 80 volts, and a voltmeter placed across them corrected for that voltage.

The practice is to correct the instrument for every 10 volts, altering the resistance in the Wheatstone bridge to

suit each case, and in order to arrive at the amount to be unplugged it is usual to regard the ratios as even numbers and subtract seven each time. Thus to balance for 40 volts, regarding the box resistance as 100, we should have to unplug in the Wheatstone resistance 39 hundred, and subtracting seven gives us 2,893, which is the correct amount; the dynamo is then slowed down until a balance is obtained, and the voltmeter reading noted for correction accordingly.

There is another method of calibration which is far more simple and proportionately rough; it consists in joining the searchlight resistances all in series. Each of these has a resistance of ·2 ohm, and can carry 100 amperes of current with safety; consequently four of these can be put across the dynamo terminals, and there will be 20 volts fall each. Presuming that the pilot lamp will show approximately if the dynamo is giving its correct 80 volts, three other readings may be obtained. Ammeters can always be checked if one's voltmeter and Wheatstone bridge are in order, and besides they do not intrude themselves upon the torpedo lieutenant's notice to the same extent as the voltmeter, for it must be remembered that the lights in the captain's cabin are among the most distant from the dynamo, and that captains are liable to be very low reading voltmeters on their own account, and are not inclined to enter into lengthy arguments where their eyesight is at stake.

By all means let the meter in the dynamo room read only 80 volts, but at the same time let it not be at variance with the captain's judgement; he is not likely to go pottering about down below for the purpose of proving himself in the wrong, and if Mahomet will not come to the mountain, there is only one course open to the mountain, if peace is to reign among the torpedo staff.

THE BOARD OF TRADE BRAKE.

The Board of Trade is a much maligned body—albeit its corporate pretensions are almost astral—and it is felt popularly that its powers are used more often to discourage than to promote the Briton's enterprise. Popular verdicts are often wrong; but we do not propose to take this opportunity to act as the apologists of the Board, especially as we are constrained to call it over the coals for one of its latest exhibitions of inertia.

That excellent non-sectarian body, the Tramway and Light Railway Association, which works for the good of the whole body of tramway undertakers, be they corporate or company, and through them for the public, has been corresponding with the B. of T. with the object of obtaining advantages for the tramcar in point of speed which are not denied to other public vehicles.

Tramways suffer in this, as in other directions, for their age. Speed limits were unnecessary when such an admirable governor as a pair of horses was attached to the car, but when the lumbering steam-car came into use on tracks which were practically horse-car tracks, with dummy facing points at every ill-constructed turn-out, and no very adequate brake for such a weight of engine and car, it is not remarkable that speed limits were brought into operation, or that these limits should have been set as low as 4 to 8 miles per hour. Without doubt, it was dangerous to run a steam tram through the old type of fixed facing points at more than 4 to 6 miles per hour; but since those days such improvements have been introduced that electric cars of any kind, and more especially cars on single trucks, might be permitted to run through facing points at quite double the old limit, while the heavier, longer rails, deeper flanges, bigger wheels, absence of a trail car, and, above all, more powerful brakes, have raised the possible safe speed limit *at any point of any route* far above the maximum crawl vouchsafed to the steam cars.

Nevertheless the B. of T. still sticks to its 4 m.p.h. through facing points, and rarely raises the maximum speed on an urban line above 8 m.p.h., while 12 m.p.h. on a country track is considered as quite a concession to modern bustle.

We believe that when the inspectors acting for the B. of T. deliver themselves of the limiting speeds as they pass along new routes, they do not realise in the least what those speeds mean. As a general rule, the inspector's car travels over the route much faster than his own limitations permit, especially when there is a train to be caught at the end of the journey. The judicious display of a speed recorder on such occasions might lead to hitherto unheard of concessions.

We do not desire for a moment to push tramways (in which term we include here, in a most illegal manner, light railways) into the sphere of trunk railways, but we do wish to see speeds raised above the jog-trot limit of the old horse days.

Bound down as we are to an average speed (for the maximum governs the average) which is little—perhaps 1 m.p.h.—in excess of the average pace of a London to Brighton walker, we are unable to obtain a fair return on our capital outlay without using an inordinate number of cars; and passengers are forced to take as long over a journey as they had to before the advent of electric traction.

The fact is beyond dispute, even if it is not widely appreciated, that, so far, electric traction has done little to save a passenger's time when once the car has started. All the saving has been in reducing the time of the round trip, and so increasing the miles per car per day by wiping out the standing time at each end. That time used to run from 10 minutes to a quarter of an hour, and even longer in particularly bad cases, and it is the saving of that time which makes the average speed of to-day look superior to the average of five years ago.

As a matter of fact—and notorious fact at that—there are many tramways returning average speeds of 6½ to 7½ m.p.h. on which the B. of T. limit is no more than 8 m.p.h. It is bad enough to have to travel at 7 m.p.h., but how much worse it would be if the B. of T. limit were observed strictly!

An average speed of 7 m.p.h. means a maximum in the neighbourhood of 12 m.p.h., but there are hundreds of cars doing their 15 to 20 m.p.h. over easy grades, just as comfortably and as safely as a main line express at 60 m.p.h.

But this notorious infringement of regulations will neither help nor hinder our argument, for it cannot be brought officially under the notice of the B. of T.; neither, if it does happen to be mentioned, can that body point to any ill-result arising from it.

All that can be done legitimately to convince the B. of T. that speeds much in excess of what they have been accustomed to grant—and do continue to grant solely from custom—is to carry out a series of control tests which would demonstrate beyond possibility of question how safe is an electric car equipped with modern appliances.

The secretary of the T. & L. R. A. offers to organise tests of comparative stopping power to prove that a tramcar is under at least as powerful control as a motor-omnibus, although the latter is permitted to run up to 20 m.p.h., while the former is considered by the B. of T. to reach the limit of public safety at half that speed.

Although it may seem a little impolitic to remind the B. of T. that none of its advisers have had the same practical experience as a number of men on the council of the T. & L. R. A., yet such a tone is what might be expected after receiving the almost curt reply which was addressed to the Association at the end of last year.

The difference between the address of the Association to the B. of T., and the reply of that body, is that in the former reasons are given for increasing speed, while in the latter none are given for refusing.

If it is the deliberate opinion of the B. of T. that tramcars must not be permitted to run at as high a speed as motor-cars, it is presumed that the dictum is backed by reasons.

Why should not those reasons be stated? An autocracy forbids, without reason given, but a benevolent Government should at least endeavour to flatter the intellectual vanity of its petitioners, by giving its reasons for repressive or non-extensive legislation, even if it does not believe that the petitioners are equipped sufficiently with a knowledge of the questions at issue to grasp the soundness of the arguments against their views.

We care little whether a general speed limit of 20 m.p.h. is adopted, or whether the B. of T. maintains its present practice of labelling every route with a maximum speed

according to the circumstances of the case, as seen by them, so long as the inspecting officers are converted to the generally-accepted opinion that the present maxima are much too low.

We do assert, however, that every argument which can be stated in favour of a general speed limit for motor-cars will apply with equal force to tramcars.

Wherein lies the superiority of the motor-car over the tramcar? In control? We should say not, for the braking power of the latter is at least as good as the former, and the tramcar driver is not troubled by the fear that his car will take to waltzing without notice. In stability? Everyone who knows how the weight is distributed on both types of vehicle will acknowledge that of the two the less likely to overturn is the tramcar, with 70 per cent. of its weight within 2 ft. of the ground, although we do not consider the contingency worth considering in either case. At any rate the top-deck motor-'bus, which we are using for comparison with the top-deck tramcar, cannot claim superior stability.

In means of evasion, then? Here we must obviously grant that the motor-'bus has an apparent advantage, as the tramcar cannot budge from its fixed path; but we by no means grant that facility of deviation is an unmixed advantage, or even desirable. Careful driving and powerful brakes, added to the increased caution of the public directly faster vehicles occupy a fixed route, will prevent the casualty list exceeding its present length; and, indeed, as higher speeds will tend to reduce the number of cars on a given route, and as accidents depend on cars, and not on miles per hour, the probability is that the list would decrease.

If the B. of T. gave every tramway *carte blanche* in the matter of speed there would be no more accidents than there are now, because the proprietors of English tramways have first of all a wholesome fear of criminal actions arising out of culpable negligence, and, secondly, a great objection to ruining their business by payments in compensation. They would make therefore such regulations as would ensure safety at dangerous places.

It is evident from the attitude of the B. of T. as expressed in the letter to the L.R. & T.A., that tramways must not expect to be given equal treatment with their competitors, but it is still possible that properly urgent representations made in an effective and convincing manner to the inspecting officer may result in speeds up to the motor-car limit being granted to individual undertakings; but the immediate prospects are not too bright if we recall the recent case of Metropolitan Tramway Co., quoted by Mr. Benedict, who were refused a speed limit of 16 m.p.h. between Edgware and Cricklewood, although motor-'buses run from Piccadilly to Kensington Church at a speed, *inclusive of stops*, of over 12 m.p.h.

Competition for public favour between the tramcar and motor-'bus will not be as disastrous to the former as our daily "Universal Specialist" excitably predicts, but it will be favourable to the latter in the important matter of speed if the B. of T. does not take off the galling hobbles which nothing but archaism can continue.

CONSIDERATIONS RELATING TO THE DESIGN OF THE ARMATURE SLOT INSULATION IN HIGH VOLTAGE ALTERNATING CURRENT GENERATORS.

By H. M. HOBART.

Small selected pieces of very thin natural mica are often found to have enormously high disruptive strength. Some investigations by Steinmetz on the disruptive strength of natural mica were published in 1893.* From the curve in fig. 1, which has been derived from Steinmetz's results, it is seen that the disruptive strength expressed in effective volts per millimetre thickness of sample, approaches with diminishing thickness the limiting value of nearly 300,000 R.M.S. volts per millimetre thickness. These investigations dealt with very small thicknesses of mica. Baur's analysis of the mica for which a curve is given in O'Gorman's paper,* led him to results for greater thicknesses, and the lower Curve B, of fig. 2, has been plotted for these results. The upper Curve A, is merely a reproduction of Steinmetz's curve from fig. 1. Considering that the results were made by different

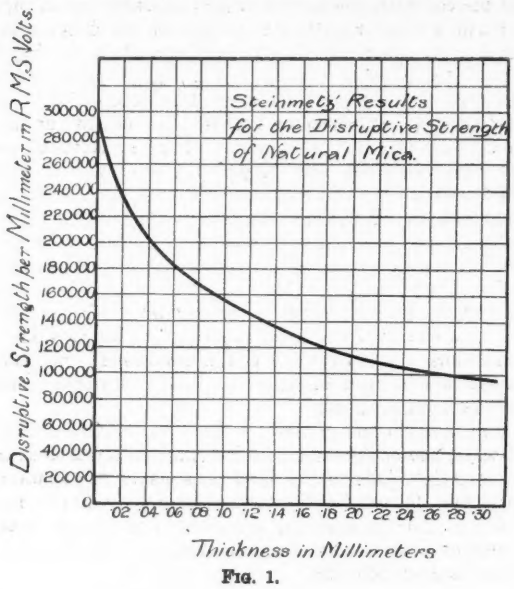


Fig. 1.

observers with different grades of mica, and that they used different shapes of electrodes, the small differences are, at any rate, of minor importance, for far greater variations are found in practice in natural mica. Comparisons could be multiplied were it worth while, and to make a single further comparison, we may quote Andrews's† reference to "a good quality of clear

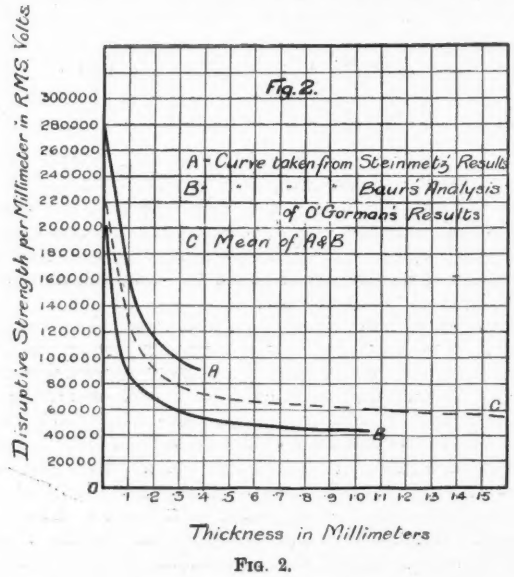


Fig. 2.

white Indian mica, a sheet of which 0·051 mm. thick would stand a pressure of 8,000 R.M.S. volts." This gives us the following comparison :—

	Thickness.	Disruptive strength in R.M.S. volts per mm. of thickness.
Andrews	0·051 mm.	157,000
Mean of Curves A and B of fig. 2 ...	0·051 mm.	165,000

The writer has recently investigated and compared the designs of 37 alternating current dynamos of various sizes

* "Note on the Disruptive Strength of Dielectrics," C. P. Steinmetz, *Transactions American Institute Electrical Engineers*, Vol. X., February, 1893.

* "Insulation on Cables," Mervyn O'Gorman, *Proceedings Institution Electrical Engineers*, Vol. XXX, p. 641, fig. 9 (1900-1).

† Contribution to the Discussion on a Paper by C. E. Skinner, entitled—"Energy loss in commercial insulating materials when subjected to high potential stress. *Transactions American Institute Electrical Engineers*, Vol. XIX., p. 1063, 1902.

and voltages, and manufactured by firms in many different countries. As regards the thickness of the slot insulation from the armature conductors to the iron core, variations of over 100 per cent. for a given size and voltage were found. The mean values are shown in the upper Curve A of fig. 3. Now this is, of course, not the first time that an attempt has been made to systematise this matter of slot insulation thicknesses. Thus, in an article on p. 4 of Vol. 1 of "Traction and Transmission," 1901, Mr. Parshall made recommendations for slot insulation thicknesses from which the lower Curve B of fig. 3 has been plotted. Although attention to quality of material and to details of its application

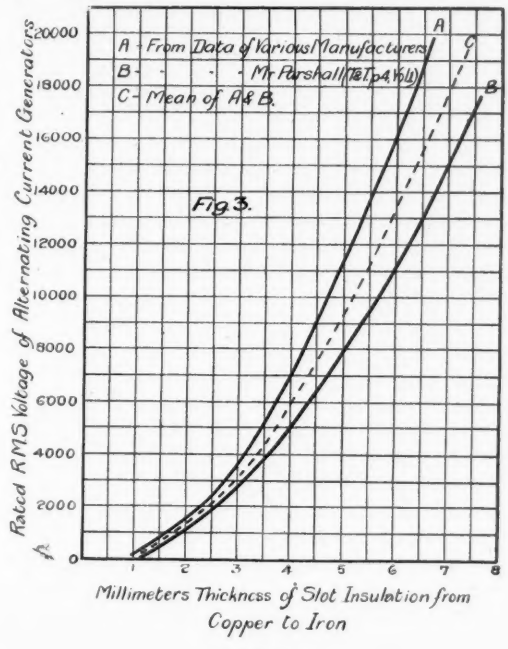

A - From Data of Various Manufacturers
B - - - - Mr. Parshall (T&T p4 Vol1)
C - Mean of A & B.
Fig 3.
Rated RMS Voltage of Alternating Current Generators
Millimeters Thickness of Slot Insulation from Copper to Iron

Fig. 3.

is, within limits, far more important than mere thickness, it is important to be conservative in such a case, and so the mean Curve C, drawn dotted in fig. 3, will, for the purposes of this article, be taken as representative of good modern practice. Analysing the values represented by the dotted curve in fig. 3, we obtain the results shown in Table I.

Table I.

Rated voltage of dynamo in R.M.S. volts.	Standard thickness of slot insulation to employ.	Average stress at rated voltage in R.M.S. volts per millimetre.
500	1·30	385
1,000	1·75	570
2,000	2·47	816
4,000	3·35	1,200
8,000	4·60	1,740
12,000	5·67	2,120
16,000	6·67	2,400

Consider now the curves of fig. 4. The upper Curve A shows the specific disruptive strength of natural mica, one of the highest insulators as yet discovered. The lower Curve B is plotted from the values in the last column of Table I., and represents present standard practice for alternating current generators. Several questions arise. The first is:—Why do we in our designs permit an increasing specific stress with increasing thickness, as shown by curve B of fig. 4, in spite of the fact that the specific disruptive strength of insulating materials in general, appears to decrease with the thickness? To this it may be answered that we cannot, for mechanical reasons, safely go much below 1 mm. for the thickness of the slot insulation, no matter how low the voltage of the machine. This has accustomed us to the employment of a high factor of safety in low voltage machines. But for high voltage machines it can only be admitted that we make a virtue of necessity. One would gladly have a factor of safety of at least 5 in high tension alternators, but even were the cost not prohibitive, other important features of a good design would have to be sacrified. So while it has come to be recognised that it is in the interests of a sound design to insist on a factor of safety of at least 5 for machines of 500 volts, a 5,000-volt machine is rarely required when tested before shipment from the works, or when first installed, to have a factor of safety as high as 3, and it would be more correct to state that 2 is more common practice. Let us, however, regard 3 as the correct factor of safety of a 5,000-volt machine, and 2 as the corresponding value for a 15,000-volt design. Taking intermediate factors of safety for designs of intermediate voltages, we obtain Curve S, of fig. 4, for the dielectric stress per millimetre thickness of slot insulation during the time that the completed machine is under test. The curve still rises with the thickness, and this can only be met by the employment in high voltage machines of higher grade material, and by the most careful study of and attention to detail in manufacture.

The experienced manufacturer will, however, allow himself an additional factor of safety over that required by the specification. Setting this at 33 per cent., we obtain Curve T of fig. 4. Even this curve does not represent the highest specific voltage to which the material will be subjected. The manufacturer should make high tension tests at every stage of construction, mitigating their severity as the machine approaches completion. Thus the coils will, before connecting up, be individually tested with a somewhat higher voltage, and in the case of form-wound coils they will be tested at an even higher voltage than this, before being inserted in place on the armature core. Even then the insulation must not be harmfully strained, and so we may say that even then we must keep down to, say, two-thirds of the ultimate disruptive strength of the insulating

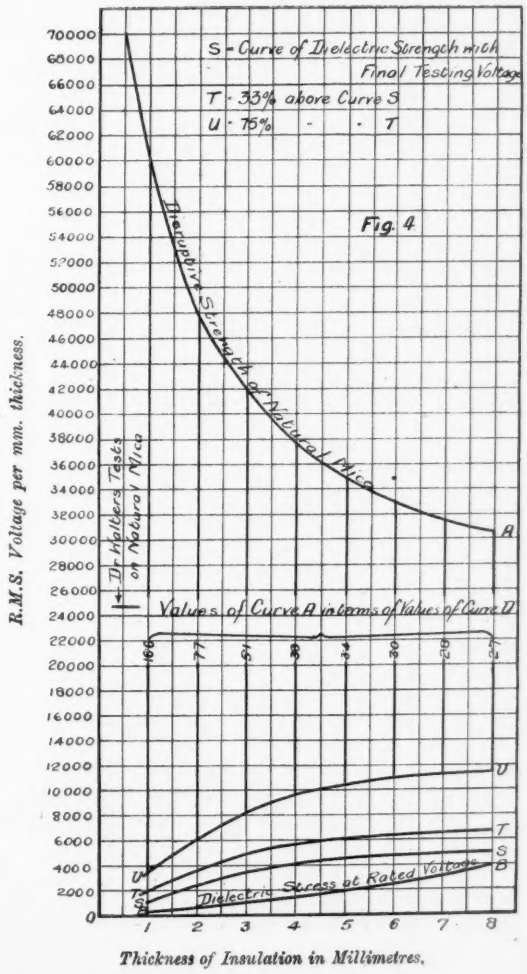


Fig. 4.

covering on the coil. Hence we may draw Curve U 75 per cent. higher than Curve T, as representing the ultimate disruptive strength in R.M.S. volts per millimetre thickness of the material *after being applied to the coil.*

(To be continued.)

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Lightning Conductor for a Small Yacht.

Fitting a lightning conductor to the boat mentioned by your correspondent "M. S." would be a wise precaution, especially as it is a wooden ship with wire rigging. It could never cause an added danger, at any rate, if the "earth" connection is maintained good.

The simplest method of "earthing" is in this case to carry the connection straight down to the heel of the mizzen mast and thence by the shortest way to the frame of the engine. It would then be "earthed" through the propeller shaft and blades. The connection should be of stout copper wire, say No. 4 S.W.G., and if it is carried to a few inches above the mast-head and then given a slight bend over, a lightning-rod need not be fitted. It is desirable whenever possible to bring all wire rigging, stays, &c., into metallic contact with some point on this "earth" connection.

R. Elliott Turnbull.

Bromley, *April 17th*, 1905.

Application for Provisional Order.

If two companies, one having the support of the local authority and the other not, applied for a provisional order for the supply of electricity in the same district, would the one having the council's support stand a much better chance of obtaining the order?

Foucault.

[It is safe to say that, other things being equal, the company not favoured with the approval of the local authority would have no chance whatever of obtaining a provisional order.—Eds. E.R.]

Tests on Stirling Boilers at Neepsend Works.

Before congratulating Mr. Fedden upon the results, it would be well to make use, as far as possible, of the information which he has been so good as to publish for the benefit of his brother engineers, to see whether certain of the particulars confirm each other:—

First, with the intention of seeing if it will be wise to accept the statement that an efficiency of some 84·9 per cent. has been obtained; such a result must be accepted with a certain amount of reserve, as it is not in accordance with what is generally known as to the evaporative performance of steam boilers, even with the most complete plant. Secondly, with the idea, if the particulars do confirm each other, of seeing the way to do likewise.

The coal is stated to have a calorific value of 11,886·7 B.TH.U., the moisture being 5·2 per cent., while the total ash and clinker amounted to 7·72 per cent.; from this it results that the combustible material in the coal was 87·08 per cent.

As the combustible matter in a coal may be taken to bear a direct relation to its heat value, one would be quite right in considering that a coal having such a large proportion of combustible matter would have a higher calorific value than stated. If we take the combustible matter to be only of carbon heat value, and deduct the loss due to the moisture, it will then have a heat value of some 12,577 B.TH.U. But it is well understood that the combustible matter in a fuel has a higher value than that, due to the hydrogen present, and the empirical formula—calorific value = per cent. combustible matter × 161·07 − per cent. moisture × $\frac{400}{1·99}$ is found to give on the basis of combustible matter in coal, a heat value in very close accord with that as determined by carefully conducted calorimetric tests.

This formula gives the heat value of the fuel used as being 12,975 B.TH.U., which will mean an efficiency of 77·7 per cent., or, if we take it on the basis of the combustible material being only of carbon heat value, the efficiency would then be 80·20 per cent.; but the ash taken is that as given in the published particulars, and as this would, no doubt, contain a certain amount of combustible matter—probably one-third—the ash, as found by analysis, would be something in the neighbourhood of 5·15 per cent., and on the supposition that the moisture was as stated, the actual combustible material in this fuel would be something near 89·65 per cent., and may be considered to have a heat value of some 13,388 B.TH U., or 12·65 per cent. more than stated, and not far short of that mentioned by your correspondent of the 31st ult., and this would mean an efficiency of 75·4 per cent., and not 84·9 per cent. as stated.

This is on the assumption that the particulars given as to the amount of ash and clinker are correct, which is more likely to be the case, as this quantity can be more easily determined than that of the heat value of the coal; this seems to show that the apparatus used for the purpose of determining the heat value of the coal, for some reason or other, has given a too low value.

On the other hand, if we are to consider that the calorific value, as stated, is correct, then it will mean by the empirical formula that such a coal would have some 80·32 per cent. combustible matter, and about 14·48 per cent. ash—that is, taking the per cent. moisture as stated as being correct. This would mean that the one side of the heat balance would be somewhat as follows:—

Boiler efficiency	84·9	per cent.
Loss in flue gases	10·84	„
Heat losses in radiation, and ashes ...	4·26	„
	100 00	„

The last item would represent that the heat loss by radiation, ashes (sensible heat and heat lost due to the unconsumed carbon in the ashes), and otherwise unaccounted for, would only be some 4·26 per cent., an amount a good deal less than is usually found to be the case for the losses in this respect in steam boilers.

It appears from this that of the two errors the one of under-estimating the heat value of the coal, rather than the amount of ash and clinker, is more likely to have occurred; and, from what is known of the heat value of coals, it is quite reasonable to suppose that a coal having so low a value as stated would also have some 14 per cent. ash.

So, before the results can be accepted, I think it would be well if Mr. Fedden would kindly give the approximate analysis of the coal, and, at the same time, it would, no doubt, be of considerable interest if he would publish the heat balance of the test.

Calories.

A.C. v. D.C.

As a regular reader of your paper in this land of niggers, coloured people, white people, and people of no colour at all, may I be allowed to say a word with reference to some absurd correspondence (referring to the writers only), which has appeared in your issues of March 3rd and March 10th, entitled "A.C. *v.* D.C."

In your issue of the 3rd inst., Mr. W. Talboys Wheeler, second assistant to the Tunbridge Wells Corporation Electricity Works, appears to think that all A.C. men are vastly superior to D.C. men. Personally, I have never held the exalted position of "Second Assistant Engineer" (whatever that may mean), but I happen to have been "Chief Assistant Electrical Engineer" in a town very near to Tunbridge Wells, to wit, Hastings, which is an A.C. station, and, at the present moment, I happen to be joint station engineer in a D.C. station in South Africa. Personally, perhaps, I cannot say that my experience with D.C. work has been much more difficult than with A.C. work, but, in nine cases out of ten, I should certainly say that a D.C. station is far more complicated (as regards the switchgear and mains network) than an A.C. system. I learned practically all I know about A.C. work from my old chief, Mr. Leonard Andrews, and beyond the fact that A.C. work is more "dangerous" than D.C. work, I think I may say that even Mr. Andrews will agree with me that D.C. work is more complicated in many ways (in fact, in most) than A.C. work. From the wording of his letter, it appears to me that Mr. W. Talboys Wheeler must have been disappointed in an attempt to obtain a position in a D.C. station. What I want to point out is that it appears to me to be so abso-

lutely puerile for men, even in such positions as second assistant engineers, to write such stuff.

If a company or council running an A.C. station are requiring an engineer, it is only natural (and only fair) that they should ask for a man who is used to such work. The same applies to a D.C. station. Mr. W. Talboys Wheeler's argument about "the greater including the less," as applied to this matter, is absurd. One might as well say that the greatest authority on civil engineering (which branch of the profession is admittedly the senior) is competent to run any electric light station in existence. One might also say that a Royal Engineer officer is quite competent to become an artillery officer on the grounds that "the greater includes the less," the Royal Engineers being senior to the Royal Artillery. I wish men would not be so illogical.

Charles Dudding.

Cape Town, South Africa.
March 30th, 1905.

The Localisation of Faults on Cables.

I have read with much interest the correspondence which has appeared recently in the ELECTRICAL REVIEW on the localisation of faults in electric light mains.

Having digested the articles which appeared in the *Electrical Magazine*, I should like to point out that the views expressed by Mr. Bergh are quite correct.

The point that seems to trouble most of your readers is whether it is advisable to remove consumers' fuses or not. This is quite unnecessary, as is easily seen if one gives the matter serious thought. The testing, of course, is never carried out at the peak of the load, for to disconnect mains at such a time would be entirely out of the question. If there are a few lamps on when the test is taken, they will shunt a *very small* portion of the current, as the resistance of the lamps is high in comparison with that of the voltmeter. This, of course, is immaterial, as the test does not depend on the absolute value of the voltage drop; moreover, the shunting resistance remains practically constant between the readings of v_1 and v_2.

I do not think that "Weary Willie and Tired Tim" need tire themselves any more in removing consumers' fuses, as, from practical results, I can say that such a proceeding is quite unnecessary.

Arthur L. Johnson.

Brighton, *April 19th*, 1905.

Electricity in Mines Regulations.

"Q's" letter on this subject may be worth a thought. Let it be assumed that the space not occupied in a motor case is 1 cb. ft., and that an explosive mixture of 1 : 8 is present. Then assuming that 1 cb. ft. of gas contains 630 B.TH.U. of heat, there will be 70 heat units in the space of 1 cb. ft. From the table of the properties of gases in Kempe's Year-book, hydrogen is credited with 293 B.TH U. per cb. ft., methane with 1,073, and ethylene with 1,744. The weight of a cb. ft. of the mixture is about 0·08 lb. The specific heat of the products of combustion may be 0·2. Then the heat produced is at the rate of $70 \div 0{\cdot}08 = 900$ B.TH.U., nearly, per lb., and the temperature added is $900 \div 0{\cdot}2 = 4{,}500°$ F., nearly. As the initial pressure is 15 lb. down a mine, or very closely so, and the initial temperature is close upon 500° absolute, the pressure on explosion will be $15 \times 5{,}000 \div 500 = 150$ lb. per sq. in. Since the specific heat of gases increases considerably with temperature, it is very unlikely that anything approaching a temperature of 5,000° absolute will be secured, and the pressure will fall below 150 lb. by a corresponding proportion. Mine managers who know what is the proportion of gas and air in a mixture can readily calculate for themselves on the above lines what will be the pressure in any particular case. If more gas be present, there will be more heat units available, but there will be insufficient oxygen to bring them into action. The table referred to above gives the heat units per cb. ft. of coal gas as 685, but this does not necessarily apply to the firedamp of the mine. Also it gives 6·16 as the ratio of air in 7·16 of chemically equivalent mixture. Our calculation therefore will not, perhaps, seriously depart from fact. Clearly the main point is the value of the coefficient of specific heat. At 2,000° C. = 3,600° F., the molecular specific heat of CO_2 is 19·1, or treble the ordinary value, while that of steam is 16·2, or over double the ordinary value. In the combustion of firedamp so much steam is formed with a normal specific heat of 0·370 at constant volume that the mean specific heat of the products of combustion will be about 0·257. With a temperature of about 2,500° F. absolute, the value of the specific heat will probably not be far from 0·5 for the mixed products, whence the temperature would be $500 + (900 \div 0{\cdot}50)$, or 2,300° F., a sufficiently close approximation for the nonce, and the pressure would be about five atmospheres, or one-half that found on the basis of a constant specific heat. Even if the presence of the atmospheric nitrogen with its smaller specific heat be taken into the calculation, the result would probably not exceed 100 lb. pressure in a casing, and this pressure would be most rapidly lost by cooling, more especially where the motor was at work within. Indeed, Clerk states that coal gas and air in a closed vessel at atmospheric pressure cannot give an explosion pressure of even 100 lb. per sq. in., and the weakest mixture that will ignite will only give 52 lb. pressure. It is hardly likely that the most explosive mixture will ever be present in a motor case, and it should not, therefore, be a very difficult matter to design a case to be safe under the conditions named. The interior of a motor case cannot contain a mixture above atmospheric pressure, and this fact prevents any such high pressures of explosion as occur in a compressed mixture, as in a gas engine.

B.

Re Telephone Licence.

In reference to running outside telephone wires (overhead), I shall be glad to learn whether I am compelled to obtain a licence from the Postmaster-General, who, I understand, is the licensing authority, before I can do this. I shall be much obliged if you will state fully as to what I am obliged to do before commencing work.

In the Dark.

[As recently stated in these columns, if the line joins two establishments belonging to the same person or firm (A to A), no licence is required. If, however, the line provides communication between two distinct individuals or firms (A to B), a licence must be obtained from the Postmaster-General, to whom our correspondent should apply for full information.—EDS. E.R.]

Schedule Prices for Electric Light Installations.

I was very much interested to read "Estimator's" letter in your issue of April 7th, which severely criticises the prices of the successful firm tendering for assisted wiring for the Erith U.D.C.

It appears to me that if anyone is at all distant from the profession and out of touch generally with "cutting prices," it is the "Estimator."

I do not doubt his practical experience for a moment, but workshop experience and business management need separate study.

Whether in the trade or no, it is hardly likely that the work will be done at any loss, or inferior materials used, as tendering upon these lines would be absurd.

I am equally as pleased to see my friend's tenders in "Contracts Open and Closed," but sorry that he is "frequently a good distance from the lowest tender;" probably if he were a more competent "Estimator" he would have his fair share of the work put out for tendering.

"Every man has a bag hanging before him in which he puts his neighbour's faults, and another behind him in which he stows his own."

Coriolanus, ii. 1.

Non omnia possumus omnes.

Another Contractor.

[Address Wanted.—Will Mr. R. Stanley-Smith kindly communicate with us?—EDS. E.R.]

PARLIAMENTARY.

Telephone Dangers.—Sir Thomas Dewar asked the Postmaster-General whether, in view of the proposed acquisition of the National Telephone Co.'s undertaking by the Government, he would suggest to the company the expediency of insulating their telephone cables in a manner most likely to minimise the risk of fires such as those which occurred recently on the company's premises at Cannon Street and Queen Victoria Street; and whether steps were taken to secure that Post Office cables were satisfactorily protected against the risk of contact with electrically-charged conductors.—Lord Stanley, in reply, said: "I am assured by the National Telephone Co. that they are fully alive to the necessity of adopting all proper precautions for the protection of their exchanges from fires of the kind mentioned. The question is one that had engaged the close attention of my department, and all possible means are taken to guard the Post Office system."

Accrington Corporation Bill.—The Lancashire Electric Power Co. and the Lancashire and Yorkshire Railway Co. have deposited petitions in the Private Bill Office of the House of Lords, praying to be heard against this Bill.

Baker Street and Waterloo Railway Bill.—This Bill, which asks for an extension of time for the compulsory purchase of land; authority to pay interest out of capital during construction; and further powers as to new subways, was before the Unopposed Bills Committee of the House of Commons on 13th inst., Mr. J. W. Lowther presiding. Mr. Cripps, the agent for the Bill, stated that the financial proposal was somewhat novel; it was that the company should have power to issue debenture stock, the certificates of which should be transferable by delivery, instead of having debenture stock registered and transferable under ordinary law. The Hon. Sir E. Chandos Leigh, K.C. (a member of the Committee), remarked that the difficulty which presented itself to his mind was that of obtaining the necessary consents to any action the company might propose to take if the clause were adopted in its present form. Mr. Cripps said that it was proposed to deal with that by inserting a clause providing that the terms of issue should be endorsed on the certificates. If the consent of that class of debenture holder was required, advertisements would be published summoning a meeting. The clause gave the holder of stock the option of having it registered. Mr. Metcalf, of the Stock Exchange, told the Committee that all the great frauds of recent years had been committed with stock that was registered. In the present proposal the advantage to the company would be that they would have a wider market; the advantage to the public would be a more marketable security. The Committee passed the clause.

South Wales Electrical Power Distribution Co.'s Bill.—This Bill came on on 13th inst. as an unopposed measure before the Chairman of Ways and Means. The object of the Bill is to authorise the transfer to the company of the undertaking and powers of the Carmarthenshire Electric Power Co., which was incorporated in 1903, and to confirm an agreement affecting the transfer. Powers are also asked to extend the periods limited by the Act for the purchase of land, and for the commencement of works, and to extend the area of supply so as to include the parish of Llanelly. The Bill was ordered to be reported for third reading.

Andover Lighting and Power Bill.—The above Bill came before Mr. J. W. Lowther's Committee on 13th inst., when there was no opposition. Mr. Anderson (Parliamentary agent for the promoters) stated that the Bill re-incorporated the Andover Gas Co., and enabled them to take powers for an electric power undertaking. In answer to Sir Chandos Leigh, it was stated that the company were proceeding by way of provisional order this session for electric lighting powers. Formal evidence was given in proof of the preamble, and the Bill was ordered to go for third reading.

Halifax Corporation Bill.—Mr. J. W. Wilson's Select Committee in their report to the House of Commons on this Bill, the preamble of which they have passed, stated that they had allowed 30 years as the period for the repayment of £24,989, the cost of the construction of tramways, and 20 years for the £8,245 required for the electrical equipment in connection with the Corporation tramways. The period of loan for any further money which may be required for these purposes is left to the Board of Trade.

Edgware and Hampstead Railway Bill.—On April 13th the Unopposed Bill Committee of the House of Commons had before it the Edgware and Hampstead Railway Bill, which seeks power to make a deviation railway at Hampstead so as to join up with the Charing Cross, Euston and Hampstead Railway, and also enable the company and the Watford and Edgware Railway to make agreement with the Underground Electric Railways Co., Ltd., for the supply of electric current, &c.—The Bill was ordered to proceed.

London United Tramways (Extension of Time).—The opposition to this Bill having been withdrawn, the Bill was referred to the Committee on Unopposed Bills.

Metropolitan District Railway.—The opposition to this Bill having been withdrawn, the measure has been referred to the House of Commons Committee on Unopposed Bills. The Bill had previously passed the House of Lords.

West Cumberland Electric Tramways (Extension of Time) Bill.—It is announced that all opposition to this Bill has now been withdrawn. The Bill has already passed the House of Lords, and has now been referred to the Committee of the House of Commons on Unopposed Bills.

Electric Lighting Provisional Order Bill (No. 2).—On Tuesday last week the Examiner considered the above Bill for proof of compliance with Standing Orders. The Bill confirms a Provisional Order under the Electric Lighting Act granted to the Rural District Council of Castlerea, in respect of the township of Ballaghaderreen, and portions of the townlands of Lung Frierakill, Knockanaconny, Ballaghaderreen, and Kilcolman in the county of Roscommon. The Bill was ordered to proceed.

LEGAL.

MIDWOOD & CO. *v.* MANCHESTER CORPORATION.

IN the Court of Appeal, on Wednesday last week, before the Master of the Rolls and Lord Justice Cozens-Hardy, an application for a stay of execution and for leave to expedite the hearing of an appeal in the case of Midwood & Co. *v* the Manchester Corporation, was made by Mr. Gordon on behalf of the defendants. Counsel said the action was brought against the defendants, who were the electric lighting authority for the district, for damages in connection with a fire at plaintiff's house, which was attributed to a defect in the main supplying the district. The action was tried before Mr. Justice Lawrance and a jury, and in the result there was a verdict and judgement against the Corporation for £677 and costs. There was a motion pending for a new trial. The facts were rather complicated. Midwood was really only the nominal plantiff, he having been indemnified for the loss he had incurred by an insurance company, who were the real plaintiffs in the case. In these circumstances the defendants asked for a stay of execution, or, if they paid the damages over, that the insurance company should give an undertaking to return the damages if the appeal proved successful.

Lord Justice COZENS-HARDY: Has the fire insurance company paid the money to plaintiff?

Mr. GORDON: Yes, and if the verdict stands the money is paid to the insurance company. They are the persons really conducting this litigation. We must have an undertaking, or security, if the damages are paid.

Their LORDSHIPS said that the application must be made to the judge who tried the case. The application was accordingly dismissed with costs.

BUSINESS NOTES.

Fulham.—The contract for installing telephones and electric lighting in the Fulham Town Hall extension has been placed with the Telephone and Electrical Installation Co., of 11, Queen Victoria Street, E.C.

Tramcar Lifeguards.—Messrs. Hudson & Bowring, Ltd., of Manchester, have recently received through the Brush Co. the following orders for lifeguards:—For Belfast Corporation tramways, 170 cars; for Yarmouth Corporation tramways, 10 cars; and for Leith Corporation tramways, 15 cars.

American Works Extension.—The directors of the Allis-Chalmers Co., of Milwaukee, have decided to spend three million dollars on the extension of their works for the purpose of manufacturing electrical machinery of the largest type, as well as steam and hydraulic turbines and gas engines. The electrical department at Milwaukee will be operated in connection with the big plant of the Bullock Electric Co., at Cincinnati, which is owned by the Allis-Chalmers Co.

American Electrical Exports.—The value of the electrical appliances exported from the United States during February last amounted to £83,696, as contrasted with only £74,176 in the corresponding month of last year. There was also an increase in the shipments of electrical machinery from £102,141 in February, 1904, to £127,495 in February last. Japan is at present America's best customer for electrical machinery, being responsible for £28,358 of February's total, Mexico coming second with £27,101, Canada third with £17,685, and England fourth with £15,551.

Stockton Destructor.—The Corporation of Stockton-on-Tees has just resolved to place with the Horsfall Destructor Co., Ltd., of Leeds, an order for the extension of its destructor. The existing plant, which was erected by the Horsfall Co. in 1901, has, we are informed, given results averaging 10 per cent. better than the company's guarantee throughout the whole time, and the extension has been undertaken owing to the necessity which has arisen of burning a larger quantity of refuse.

Hornsey Electrical Exhibition. — The Hornsey Borough Council is to hold an electrical exhibition at the Public Baths next January, from 15th to 27th. A notice relating to the same appears among our advertisements to-day.

The Canadian Westinghouse Co.—At the meeting of this company, held in Canada on March 28th, it was reported that up to December, 1904, the company had only been organised 14 months, and during that time the profits were over $160,000, notwithstanding the fact that the company had not yet completed its elaborate scheme of new works. The company commenced the current year with orders on hand of approximately $560,000. When the plant is finally completed there is every expectation of a large and growing business in both the air brake and electrical departments.

Fires.—Extensive damage was done by fire, on April 18th, at the works of the Morley Electrical Engineering Co., Stanningley. The outbreak originated in the offices, and the flames spread very rapidly to the interior of the works. Many patterns and drawings were destroyed, and the dynamos and motors were damaged by water. The loss is estimated at several thousand pounds.

Damage to the extent of £750 was caused by fire, which broke out in the premises of Messrs. Laird Brothers & Co., electricians, Brunswick Street, Glasgow, on Tuesday afternoon.

Deed of Assignment.—A first and final dividend is to be paid in the matter of a deed of assignment executed by William Brown (W. Brown & Co., electrical engineers, 4, Birley Street, Blackpool). Creditors must send particulars to the trustee, Mr. James Todd, 18, Birley Street, Blackpool, by May 8th.

Trade Announcements.—The Wandsworth Electrical Manufacturing Co, Ltd., manufacturers of electrical fittings, have removed from their address at Mary Street, Birmingham, to 9, St. Paul's Square, Birmingham.

The Reed's Electrical Co., of London, have opened a branch for the North of England at 24, Charles Street, Bradford, where a large stock of their specialities will be kept. Mr. Charles Pullan has been appointed manager for this branch.

Messrs. Frew & Co., Ltd., of 6 and 7, Mill Street, Perth, notify that they have acquired the business hitherto carried on by Frew, Watson & Co., Ltd. (now in liquidation), together with the goodwill, book debts, stock-in-trade, plant, and machinery connected therewith, and that they will in future carry on the business in all its departments under the management of Mr. T. D. Frew.

Messrs. F. W. Berk & Co., Ltd., of 1, Fenchurch Avenue, E.C, announce that they have registered Berk's accumulator acid as B A A.

Catalogues and Lists.—Messrs. Geo. Hopkins and Sons, 150—154, St. John Street, Clerkenwell, E.C. Illustrated lists of electric hoists, leather belting, three-throw pumps, shafting, plummer blocks, hangers, &c. The firm specialises in motor installations and in central station and other plant repairs.

Cambridge Scientific Instrument Co., Ltd., Cambridge. Loose illustrated sheets of a number of instruments, including laboratory spectrometer, telescope and scale, Dolezalek electrometer, and vapour pressure apparatus.

Messrs. Vickers, Sons & Maxim, Ltd., River Don Works, Sheffield. Section 2 of their new catalogue of particulars and prices of continuous-current variable speed motors of protected and enclosed ventilated types. A general specification, also tabulated details of dimensions, outputs, &c., are given. Section 3 is to be issued shortly, giving full particulars of the firm's continuous-current crane-type motors.

Messrs. Neale & Wilkinson, 32, St. Mary Axe, E.C. New A.B.C. tariff of rates for the conveyance of goods and parcels to all parts of the world. Places are arranged alphabetically. Copies of this pamphlet (26 pages) will be forwarded on application.

Mr. Harry Snowdon, Balfour House, Finsbury Pavement, E.C. New pamphlet describing the Nodon patent electric valve, and reprinting Mr. Horace Boot's article which appeared in the Electrical Review for February 10th. Tests are also given of a 30 ampere valve, conducted under the superintendence of Mr. G. W. Partridge, at the Adelphi station of the London Electric Supply Corporation.

Messrs. Isenthal & Co., 85, Mortimer Street, W. New catalogue (of 34 pages, enamelled paper) showing, particularising, and pricing various types of electric measuring instruments and rheostats for technical and laboratory use, such as pocket volt and amperemeters, portable battery, charging and lamp-testing sets, moving-coil switchboard instruments, combination meters for electric automobiles, demonstration instruments, resistances, and so on.

Messrs. Siemens Bros. & Co., Ltd. Leaflet No. 560 and specification No. 6A just published. Leaflet 560 gives outputs, weights, and dimensions of the firm's open type G motors and new pattern G A motors, protected, ventilated, enclosed, and fully-enclosed, the range being from 40—150 B.H.P. Specification 6A describes these G A motors.

Fire Alarms.—The International Fire Service Council had its annual executive meeting at Brussels on April 17th and 18th. Matters relating to fire alarms had considerable attention, and a standing committee was formed to deal with the subject.

Trade Announcement.—Mr. A. Woodfield, late of the firm of Messrs. Woodfield & Co., electrical engineers, of Chapel Street, Luton, has commenced business on his own account at the corner of Chapel Street and Stuart Street, Luton.

Book Notices.—"Das Funken von Kommutatormotoren." By F. Punga. Hanover: Gebrüder Jänecke. M. 4.

"The Berlin-Zossen Electric Railway Tests of 1903." Translated by Franz Welz, with an introduction discussing the general subject of train resistance by Louis Bell. New York: McGraw Publishing Co. $3.

"Manuale dell'Ingegnere Elettricista." By Attilio Marro. Milan: Ulrico Hoepli. L. 7.50.

"The Telegraphists' Guide to the Departmental and City and Guilds Examinations in Telegraphy." By James Bell and S. Wilson. Fifth edition. London: S. Rentell & Co. 2s. net.

"Transactions of the American Electro-Chemical Society." Vol. VI., 1904. Philadephia, Pa.: The Society.

"Fifty-fourth Annual Report of the Amalgamated Society of Engineers." London: 110, Peckham Road, S.E.

Dissolutions and Liquidations.—The Yarmouth and Gorleston Tramways Co., Ltd., is winding up voluntarily, with Mr. S. Neville Wells, Donington House, W.C., as liquidator.

In consequence of the retirement of Mr. Frank Clemens Wilson from the firm of Messrs. Offord & Wilson, electrical engineers, of Woodcock Street, Birmingham, the business will be continued alone by Mr. Chas. Herbert Offord.

Messrs. M. Davis, J. H. Gee, and A. J. Davis (J. H. Gee & Co., electrical engineers, 27, Newgate Street, Newcastle-on-Tyne), have dissolved partnership. Mr. J. H. Gee will continue the business as J. H. Gee & Co.

New Rheostat.—We have received particulars of a very interesting new patent rheostat from the Patent Rheostat Co., of 18, Chapman Street, Hulme, Manchester. In this apparatus, wire coils and contact studs are dispensed with; the resistance consists of a series of thin sheet-metal stampings, packed into a channel on the face of the slate base of the rheostat. The contact lever makes contact directly with the resistance, thus giving a gradation equivalent to that obtained with some hundreds of contact studs. There is no sparking on the contacts, and it is claimed that the resistance is practically indestructible under normal conditions. Provision for expansion is made by a spring at the end of the resistance column, and the spring at the same time ensures continuity in the circuit. There is practically nothing on the back of the switch base; sheet-iron covers are provided for the front. The makers claim that the device forms an ideal motor starter, and it certainly represents a considerable departure from current practice.

"Pernax" Insulation.—We are informed that Messrs. Middleton & Townsend, of Edinburgh, have had a length of wire insulated with "Pernax" under test for about 18 months, under the same conditions as a number of insulated conductors of other types. Each wire was placed in an iron pipe, which was earthed through a lamp, while the copper conductor was connected with mains at 230 volts above earth. Every month the pipe was partially filled with water, so that the insulating material was alternately wet and dry. So far, the "Pernax" insulation has shown no sign of breaking down, though five out of six other kinds broke down within six months. A cable insulated with "Pernax," having a copper cross-section of 0·25 sq. in., has also been in successful use on the L.C.C. tramways for some months past. "Pernax" is allied to "Gutta Gentzsch," which has been fully described in the Electrical Review, and both are made by the New Gutta-Percha Co., of Dashwood House, New Broad Street, E.C., who are issuing a small price list of wires and cables.

Engineering Exhibition.—An exhibition and demonstration of motor vehicles and electric and pneumatic appliances are to be held at the showrooms of the Key Engineering Co., 33, Deansgate, Manchester, from May 2nd to May 5th. Invitations are being sent to all the central station engineers in the country, as well as to consulting engineers and manufacturers, and a special day is suggested for electrical men, who will thus be likely to meet their friends. The special feature for their delectation is the new fibre conduit, of which 34 miles are being laid by the Manchester Corporation; and Mr. S. L. Pearce, the city electrical engineer, has arranged to lay some of it during next week. Messrs. Cowans, Ltd., will also exhibit their own and Mr. Andrews's special types of switchgear, &c., in operation.

Bankruptcy Proceedings.—Under the failure of Henry Thorpe, electrician and engineer, 235, High Holborn, and 11, Bartholomew Villas, Kentish Town Road, N.W., the first meeting of creditors was held on April 19th, before Mr. Egerton S. Grey, Official Receiver, at the London Bankruptcy Court. The chairman reported that the debtor had stated that he commenced business ten years ago in partnership with Mr. Henry J. Salter, and contributed £750 as capital. The partnership was dissolved in June, 1904; there were outstanding liabilities which he had included in the present list, and he lost his £750 in the business, from which he drew only £2 a week. The New Century Lock and Engineering Co., Ltd., was registered in June, 1904, to take over the business and its assets, but not the liabilities. No fresh capital was provided, and as one of the vendors he (debtor) received 320 fully-paid shares in the company, of which he was appointed chairman and director. He attributed his failure to his liability for the debts of the partnership. The receiving order was made on the debtor's own petition. A statement of affairs had been lodged, showing debts £728 and assets £187 6s. 3d., consisting of the said shares valued at £157 10s. and book debts £29 16s. 3d. Mr. W. B. Glasier attended the meeting on behalf of the debtor, and no offer being submitted, the case was left in the hands of the Official Receiver, to be wound up in bankruptcy, the debtor's public examination being fixed for May 16th.

The case of James T. Armstrong came before Mr. Registrar Giffard on Wednesday last week at the London Bankruptcy Court in relation to the public examination of the debtor, whose accounts show total liabilities £6,933, and an estimated surplus in assets of £7,102 after providing for all debts. Upon the case being called, Mr. Hough, senior Official Receiver, asked for an adjournment of the examination and for an order on the debtor to file an account showing all shares and moneys received by him from the company since October, 1902, and his dealings with them, together with dates, items and particulars of the consideration. Mr. Rutland, who represented the debtor, remarked that his client was under the impression that he had given all the particulars that had been required. The Official Receiver said Mr. F. S. Salaman had just

recently been elected by the creditors as trustee to administer the estate in bankruptcy, but the debtor was contesting the order of adjudication, and until that order had been made by the Court, the trustee's appointment could not be confirmed. The case called for considerable investigation both at the hands of Mr. Salaman and himself, and on those grounds he asked for an adjournment. By consent of all parties the hearing was ordered to stand over until May 17th, and the debtor was directed to file the additional accounts by May 1st.

May 10th is the last day for receiving proofs for intended dividend in *re* A. E. Brooks, electrical engineers, 110, Cheapside, E.C.

German Electrical Imports and Exports.—According to the *Export-Zeitschrift fuer Elektrotechnik*, the imports into Germany of electrical machines for January and February, 1905, were 174,300 kgs., as against 201,600 kgs. for the same period last year. Of these machines Great Britian supplied 13,400 kgs., as against 7,100 in 1904. In turning to the German exports, we find the figures are instructive, for out of a total of 2,209,900 kgs. of electric machinery, 401,500 kgs. were supplied to Great Britain, comparing with 519,300 in 1904. The balance of exports went to Belgium, Denmark, France, Italy, Netherlands, Norway, Austria, Hungary, Portugal, Roumania, Russia, Finland, Sweden, Switzerland, Spain, Egypt, British South Africa, Japan, Argentine, Brazil, Chili, Mexico, Cuba, and the Australian Commonwealth. Great Britain sent to Germany 400 kgs. of telegraph apparatus, telephones, &c., and received therefrom 25,100 kgs. We also imported 251,900 kgs. of cables and sent 401,100 kgs. to Germany.

For Sale.—The Buxton U.D.C. is offering two balancer sets for sale. See our advertisement pages to-day.

LIGHTING AND POWER NOTES.

Australia.—Leederville, W.A.—The Council has decided on the following charges: £2 2s. per annum for an electrician's licence for the right to install E.L. fittings within the municipality; a fee of 10s. 6d. for making connections and testing works and installations done by other than the Council's officers; and a minimum fee of 15s. per point for making installations.

Bexley Heath.—The U.D.C. has applied for a loan of £1,000 for E.L. purposes.

Blackpool.—The net profit of the electricity undertaking for the past year's working is expected to approximate £5,000, or £3,000 more than in the previous year, and about £1,400 in excess of the estimate at the beginning of the financial year.

Bristol.—The L.G.B. has sanctioned the borrowing of £126,160 for E.L. purposes. The committee again considered the question of extending the private lighting mains to the Hot Wells, and decided that the mains should be laid, and extensions carried out at King Street and Downside Road.

Bury (Lancs.).—The borough electrical engineer (Mr. S. J. Watson) has reported to the Electricity Committee that he anticipates that the profit on the electricity works for the past year, after all expenses and charges have been met, will be about £3,000.

Canada.—Ottawa.—On April 5th the city authorities served formal notice upon the Consumers' Electric Co. that the municipality intends to exercise its right to purchase the property of the company.

Cardiff.—The sub-station at the Docks has been completed, and is so arranged that the Dock district can be entirely disconnected from the town and supplied from the sub-station alone; or, in case of an accident, the sub-station can assist the town lighting by means of a battery which has been installed.

Chichester.—The T.C. has decided to inform the Chichester and District Electric Light Co. that if it is unable to make the financial arrangements contemplated before May 9th next, the Corporation will be glad to have the documents back and to terminate the negotiations. The financial arrangements mentioned are the repayment of £500 spent by the Council in obtaining the prov. order for electric light.

Cleckheaton.—On the recommendation of the Electricity Committee the U.D.C. has decided to reduce the price of energy for lighting purposes from 5d. per unit (with 5 per cent. discount for prompt payment) to 4d. per unit with a graduated scale of discount from 5 to 20 per cent. in proportion to the consumption; also that for power and heating, the minimum be reduced from 200 to 150 units per quarter, with a charge of 2d. per unit on the minimum, and 1d. per unit on all above the minimum with discount as at present.

Clewer.—In consequence of opposition, the Windsor Electrical Installation Co. has withdrawn the parish of Clewer from the provisional order now being applied for. The parish desired to impose conditions which could not be enforced.

Continental Notes.—Italy.—A concession has been granted to put down plant to utilise the water-power of the River Naviglio at Cornate (Milan) in the generation of electrical energy for lighting and power purposes.

Germany.—The municipal authorities of Falkenstein have voted a sum of £22,500 for the establishment of an electricity works in the town.

Servia.—La Société des Tramways et Eclairage de la Ville de Belgrade is now supplying energy to 27,517 lamps, an increase of 1,969 during the past year. A new 600-H.P. engine and dynamo has been installed, and work is in hand on the installation of a new 800-KW. turbo-alternator.

Coventry.—The Corporation E.L. Committee has decided to extend the lighting mains to the Stoke Park district, at an estimated cost of £1,027.

Dublin.—The Lighting Committee has recommended reductions in the rates charged for electricity as follows:—The rates for general lighting to be reduced on the maximum demand system, from 7d. and 2½d. to 6d. and 2½d. The Committee does not recommend that any reduction in the flat rate of 6d. per unit should be made, as in Dublin there is an undue proportion of offices and early closing shops which cannot be considered as profitable even at the rate of 6d. per unit. The rate for energy for motive power and heating is to be reduced from 7d. and 1d. to 4d. and 1d., with an alternative flat rate of 2½d. per unit. The demand for energy for motive power is increasing, and to further encourage this and to build up a good day-load, a substantial reduction is advocated. Arrangements are being made with a firm of motor manufacturers, for the adoption in Dublin of the hire-purchase system. Flat rates for special classes of consumers are also recommended, *i.e.*, (*a*) For private residences, where the entire lighting of the premises is done by electricity, a flat rate of 4d. per unit; (*b*) for licensed premises which do not close before 11 p.m. on week-days, and where the entire lighting is done by electricity, a flat rate of 3½d. per unit; (*c*) for theatres and music-halls, a flat rate of 3½d. per unit; (*d*) for newspaper offices in which are printed morning daily papers, a flat rate of 3½d. per unit for lighting, and 1¾d. per unit for motor power. The Committee suggests that these charges should come into force as from July 1st next.

Dundee.—At a meeting of the Tramways Committee of the T.C. on Monday, Mr. Richardson, the electrical engineer, reported that he anticipated that next winter the department would have to meet a maximum load of about 2,000 KW. To meet this there was only available plant of 2,300-KW. capacity, and the loads on the outlying points had grown so rapidly that the long feeders to these districts would require to be considerably enlarged. The engineer was instructed to prepare a detailed report and alternative schemes, and also to report on the general policy of extension.

East Barnet.—The B. of T. has revoked the 1899 East Barnet Valley electric lighting order.

Electric Power in a Brickworks.—The most recent addition to the Scottish brickyards is that at Walkinshaw, near Paisley, where, for many years, an ironstone mine has been at work. Mounds of "blaize," brought from the pits along with the ore, have accumulated, and the proprietors decided to build a brickworks suitable for handling this blaize. In planning the ground, Messrs. Merry & Cunninghame, Ltd., who own also important collieries, decided to install only the most up-to-date machinery, not only for making and firing the bricks, but also for economising labour in handling them. To this end an electric hoist has been installed, capable of hoisting 100 bricks at a time into trucks for delivery to their destination, thus superseding the usual system of loading by hand, unless the lie of the ground enables trucks to be run at a lower level than the rails leading from the sheds or stock-yard. Water is pumped from the river by a motor-driven pump with a capacity of 1,000 gallons per minute; the distance from the yard, some three-quarters of a mile, is traversed by overhead cables. The dynamo for the whole works is in the main engine room. It is a B.T.H. four-pole machine, generating energy at 500 volts, and the switchboard is arranged to control not only the water pumping, the hoist, and the electric lighting of the yard and houses, but also, in the event of necessity, to supply light to the mines, which in the ordinary course derive their illuminant from another source. A 200-H.P. triple-expansion condensing engine is also installed.

Exeter.—The City Council has authorised arrangements to be made for an exhibition of electrical apparatus, appliances and literature, from June 6th to 9th, inclusive.

Exhibitions.—An electrical exhibition was opened on Bank Holiday, at the Exhibition Buildings, Vastern Road, by the Reading Electric Supply Co., Ltd., and will remain open until to-morrow evening. Mr. A. T. Cooper, the company's engineer, informs us that they have hired one of Messrs. Edmundson's travelling exhibitions *en bloc* to form a nucleus, and have secured the co-operation of about 30 private exhibitors.

The Mayor of High Wycombe opened an exhibition, organised by the Wycombe Borough Electric Light and Power Co., on the 12th inst.; it remained open until Wednesday last week.

The Loughborough Corporation, with the co-operation of firms in the electrical world, last week held an exhibition of electrical apparatus and machinery, &c., in the Town Hall, to further the adoption of electricity for lighting and power in its district.

Falkirk.—A letter has been received by the T.C. from Messrs. Bramwell & Harris, engineers to the Scottish Central Electric Power Co., intimating that the directors were willing to undertake the supply to Falkirk, of any energy which the Corporation might require in excess of that which it is able to provide with the existing plant, and that the company had had several inquiries from probable users within the Corporation area, and asking permission to supply those customers. The Council decided to do nothing until it was supplied with further particulars.

Glasgow.—The contract that the Tudor Accumulator Co. have with the Corporation Electricity Department, for the maintenance, at the annual charge of £175, of the accumulators at Port Dundas station, is recommended for renewal for a further period of 10 years.

The engineer to the Electricity Department of the Corporation has reported that it is necessary to order the following new plant, and the committee has agreed to obtain tenders:—Coal and ash conveyers for the Pollokshaws Road and Port Dundas stations, feed pumps for Port Dundas station, condensing plant for Pollokshaws Road station, and motor-generators and switchboards for sub-stations.

Mr. Lackie has informed the committee of the necessity for providing a new sub-station, or of enlarging the present sub-station, in John Street, in order to meet the requirements of the central and north-eastern districts of the city, and the matter has been remitted to a special sub-committee, which has reported that a new station must be erected.

Waterloo Street station is to be converted into a permanent sub-station, at an estimated cost of £9,704.

Hampton.—The U.D.C. has temporarily withdrawn opposition to the County of London Electric Power Bill, and entirely so in respect of the Bill of the Metropolitan Electric Supply Co, which has agreed to pay 26 guineas towards the Council's costs.

Hanley.—The T.C. has reduced the price of energy for private lighting from 6d. per unit for the first 150 hours' use per quarter, and 3d. to 6d. for the first 91 hours' use, and 3d. Circulars pointing out the advantages of electricity are to be distributed; a show room for electric fittings and novelties is to be opened at the works; and one afternoon per week set apart for residents to inspect the electricity works.

Heywood.—At a meeting of the Corporation Electricity and Tramways Committee on April 19th, it was stated that the loss on the electricity works for the past year amounted to £923.

India.—Delhi.—The general description of the scheme for the supply of electrical energy within the municipality is as follows:—The current to be continuous, low tension. For electric lighting purposes a three-wire system will be adopted. For electric traction purposes a distinct distribution system will be employed, energy being supplied to the car motors at 500 volts. Current to be generated at 500—550 volts, and distributed at 500 volts across the outer wires. The mains, distributing mains, and service lines will be partly aerial and partly underground. The licensees shall, within a period of two years after the commencement of this license, commence the construction of an electric tramway with single or double track and with all necessary sidings, turn out connections and tracks, on such portions of the routes mentioned as may be agreed upon between the Municipal Committee and the licensees with the approval of the Local Government. There is the usual provision that the L.G. shall have the option, at the end of 42 years from the commencement of the licence and at the end of every subsequent period of 10 years, of purchasing the undertaking.

Johannesburg.—At the annual meeting of the General Electric Power Co. held in March, it was reported that the average load during the past year had increased by 30 per cent. over the last half of 1903. According to a summary of that meeting in *South Africa*, an amount of £15,002 had been written off machinery and plant, £2,094 from buildings, £2,427 from stores, tools, machinery, and furniture, and a debit balance had consequently been carried forward from the profit and loss account to the general account, reducing the amount of the credit by £2,493 to £4,813. This depreciation was necessary because some of the old plant which was almost worn out stood at too high a value in the books. For the future it was decided that the company's charges to the mines should be so regulated as to enable it to declare a reasonable dividend to its shareholders, and to give an actual value to its shares. The requirements of the subscribers, principally the deep level mining companies, were growing at such a pace that it would be necessary at an early date to make a further call for the purpose of increasing the plant to meet the mines' requirements. The proposition was carried unanimously.

The chairman of the Chamber of Trade, replying to a question *re* the delay in the municipal electrification of the light and tramway services, said that there would not be any increase in light or power for the centre of the town until the end of October, and then the increase would only apply to the central or inner area. As soon as the first portion of the new plant was installed, it would relieve some of the present plant, which would be used for a portion of the other area in giving power and light.

Liverpool.—The difference in the charges for light, power, and traction now seems to be regarded as a grievance, especially as the E.P. and L. Committee contributed £16,934 to the city general rate last year. This sum, it is contended, ought to have been used in reducing the charge for electricity for lighting, and to ease the burdens of users directly, instead of easing the burdens of the whole body of ratepayers at the expense of those who use electricity for lighting. Last year the charges were 3½d. per unit for lighting, the average charge being 3½d.; 2d. per unit for power, with an average charge of 1½d.; and tramways, 1½d. per unit. This year, power users who consume upwards of 3,000 units per quarter, are being charged 1d. per unit for all in excess of that quantity, and the charge for tramways has been reduced to $1\frac{1}{10}$d.

London.—Stepney.—The following are the chief items of interest contained in the accounts of the municipal electric light undertaking for the 12 months ended March 31st last, together with comparative figures for the previous 12 months' working:—

	1905.	1904.
Total revenue	£32,125	£26,616
Working expenditure	17,288	13,823
Interest	6,661	5,454
Sinking fund	2,276	1,150
Surplus balance, less cost of temporary works...	£5,894	

It is estimated that, owing to a reduction in the price of energy £2,300 was lost to revenue. The profit balance has been appropriated as follows:—£1,601 written off capital account; £2,999 placed to reserve; £1,293 carried forward.

The engineer and manager, Mr. W. C. P. Tapper, in his report says that "the net surplus is only £91 less than the previous year, while the revenue per unit has dropped from 2·36d. to 2·11d., a figure below that charged by any other undertaking not supplying tramways in this country. The charge for current for the public lamps also shows a reduction, the average price per unit supplied for this purpose being 1·55d., as against 1·61d. during the previous year. It cannot be urged that this undertaking is being made to appear to pay its way by charging a high price for the public lighting. The total cost of each unit sold during the year was 1·73d. Rapid increase has been made in the sale of energy for power purposes, the amount for the year under review being 554,909 units, or over 150 per cent. of the previous year's sales. The results obtained emphasise the great importance of a large power supply, and the equal importance of low charges for power purposes."

Poplar.—The electrical engineer has suggested that a special tariff for light and power should be offered to power consumers. It is pointed out that some large prospective consumers of energy for power purposes are unwilling to take a supply at the present flat rate of 1½d. per unit. The Electricity Committee has decided (subject to the usual sanction) that the following alternative tariffs for energy be offered to power consumers:—To consumers entering into an agreement to take a maximum of not less than 100 KW., £3 per KW. per annum of the maximum power supplied, and a further ·8d. per unit for all units supplied, less 5 per cent discount for cash in 14 days, or, as an alternative, and for any demand, a discount upon the present flat rate of 1½d. per unit as follows: Above 100,000 and not exceeding 200,000 units per annum, 5 per cent.; not exceeding 300,000 units, 10 per cent.; not exceeding 400,000 units, 15 per cent.; not exceeding 500,000 units, 20 per cent.; exceeding 500,000 units, 25 per cent. The Finance Committee report having decided to ask the L.C.C. for a loan of £3,655, to be expended as follows:—Boiler and stoker, £1,942; connections to consumers, £618; pump, £350; meters and indicators, £315; brickwork and foundations for boiler, £100; ash elevators, £80; hopper, £50; contingencies, £200.

Shoreditch.—The Lighting Committee recently reported having considered a communication from the electrical engineer, stating that it is impracticable to procure any of the proposed new generating plant in time to use it during the Christmas load. In order to meet the increased demand, it will be necessary to generate more energy at the Whiston Street works with the existing plant, and considering that the two trunk mains now laid between Coronet Street and Whiston Street stations are worked to their full capacity, it is advisable to undertake at once the laying of two additional trunk mains between the two generating stations. The estimated cost of the work is £3,800. In order to ensure the more economical working of the department, three of the small Willans engines at Coronet Street are being transferred to the Whiston Street works, and for economy it is desirable to erect at once a feed-water heater in the boiler house at Whiston Street at an estimated cost of £590. Instructions have been given for tenders to be obtained for this work.

Paddington.—The General Purposes Committee of the B.C. on the 18th inst. recommended the approval of an agreement with the Metropolitan Electric Supply Co., consenting to the removal of the Amberley Road generating station and to the entire supply of the borough from the company's works at Willesden. The company is prepared to make, under five years' agreement with consumers, reductions in the price of energy, as follows:—Private lighting, from 5½d. to 5d. per unit for the first two years, and 4¾d. in the remaining three years; trade lighting (including churches and schools), from 6d. to 4¾d. per unit the first two years, and 4½d. afterwards. An amendment was proposed, and adopted, in favour of taking expert and legal advice before the Council committed itself.

Hammersmith.—The B.C. has agreed to supply energy to the forthcoming exhibition to be held at Olympia in the autumn, on the following terms:—(*a*) The Council to supply both continuous and alternating current as required up to 60,000 8-C.P. lamps at the exhibition stands at 1¾d. per unit; (*b*) a charge of 10s. 6d. to be made for connection and meter hire to each stand requiring 20 lamps or less, and 21s. for each stand of larger requirements; (*c*) if the cost of distribution of energy is less than ¾d. per unit,

such saving to be equally divided between the Council and the Committee; (*d*) a deposit of £600 to be paid to the Council by the Committee when the Council commences the outlay for distributing inside Olympia; (*e*) the Council to show the amount of energy used by each exhibitor, but to render the accounts to the Executive Committee of the Exhibition, which will be responsible for the whole supply.

The B. of G., on April 19th, again discussed the electric wiring tender question, which was referred to in the ELECTRICAL REVIEW of April 14th. It was moved that the three firms who had sent in the lowest tenders should be advised of the emendations and limitations in the consulting engineer's schedules, and that they be requested to prepare fresh tenders in accordance therewith. Alderman Pascall opposed the idea of three firms only being asked to submit fresh tenders, and moved that the whole of the firms who tendered for the work should be asked to tender afresh. This amendment was carried. Another member suggested the acceptance of the lowest tender, subject to the stipulations mentioned, but it was suggested that the adoption of such a course would be immoral and corrupt.

Luton.—A L.G.B. inquiry was held on April 18th relative to the Corporation's application for a loan of £5,000 for the provision of additional plant at the Electricity Works. There was no opposition.

Manchester.—The Corporation Electricity Committee has recommended the Council to reduce the price of energy from 5½d. to 4½d. per unit.

Mansfield Woodhouse.—The U.D.C. has decided to offer to transfer the prov. order for E.L. to Mansfield T.C., on the latter body paying all costs and expenses incurred.

New York.—At the recent official investigation into the cost of public lighting in the city, Mr. Henry M. Edwards, auditor of the New York Edison Co., presented the following statement, showing the cost of electrical energy per KW.-hour:—

	Manhattan.	Bronx.	Yonkers.
Cost at generating plant	2.40 cents.	2.40	4.03
Cost of energy delivered	3.70 ,,	3.00	5.10
Cost to consumer ...	15.00 ,,	15.00	15.00

The average total cost per KW.-hour during the last year was 6.32 cents, and the average cost for the last five years has been 7.98 cents. The average income per unit sold for the last year was 8.04, and for the last five years 9·01. Mr. Edwards added that in addition to paying dividends between January, 1899, and May, 1901, a surplus of $2,800,000 was made. The profit of the New York Edison Co. for 1904 was $2,293,839. They did not pay a dividend, but accumulated a surplus of $6,402,078, and wrote off $4,119,223 for depreciation. The facts elicited from the inquiries into the Edison Co.'s affairs showed that the city paid 12 cents per KW.-hour for energy. On the small consumer the company made a profit of 125 per cent., but to the large consumer, who might otherwise put in a private installation, energy was supplied for about 50 per cent. below the cost of production. There were six separate forms of contracts for customers, and a customer whose annual contract exceeded $25,000 only paid 3 cents per KW.-hour; the small consumer was charged 15 cents for the first two hours, 10 cents for the next two, 7·5 for the next two, and after that 5 cents an hour; 34 per cent. of the total Edison output was sold to the retail consumer, who provided 49 per cent. of the income. This, in 1904, amounted to $4,371,064.54 out of a total income of $8,991,635. The average income per KW.-hour was 12.27 cents. The company's officials testified that the city, in 1904, had used $80,000 worth of energy at 12 cents a unit. If the city had been treated as a wholesale customer, the amount would have been only $25,000. With regard to the cost of arc lighting, on 2,868 2,000-C.P. lamps, for which the city was charged $146 a year each, the company made a net profit of $61,948. The city was charged at the rate of about 5·4 cents per KW.-hour, while the cost at the generator was 2·9 cents.

Ossett.—The T.C. has decided to apply to the L.G.B. for a loan of £8,400 for the establishment of electric lighting works. It is proposed to run the plant in conjunction with the destructor works.

Ravensthorpe.—The B. of T. has granted a prov. order for E.L. to the U.D.C.

The Mirfield Gas Co., whose works are situated in Ravensthorpe, asked for the insertion of a clause providing that any loss on account of electric light should not be charged on the rates. The clause has been inserted, but somewhat modified. The Council is allowed five years in which to give the undertaking an experimental trial. During that time any deficit may be charged to the rates. The Council will take energy from the Yorkshire Electric Power Co., whose power station adjoins the district.

Southampton.—A L.G.B. inquiry was held on April 12th respecting the Corporation's application for a loan of £6,950 for electric lighting purposes. There was no opposition, but the inspector was asked by a ratepayer to call the Board's attention to the practice of spending money in excess of the amount sanctioned by the L.G.B.

Southport.—The Corporation and the Ormskirk Union Assessment Committee have arrived at an agreement with reference to the assessment of the Electricity Works. The gross assessment has been reduced from £9,071 to £6,500, and the net assessment from £5,528 to £3,000.

Southend.—It was stated at a meeting of the T.C. on April 19th, that instead of the estimated profit of £1,250 on the E.L. undertaking for the past year, there was a deficit of £687, with a loss of £1,055 on the tramways.

Torquay.—A letter has been received by the Corporation from the L.G.B. in regard to its application for sanction to borrow £42,000 for new electricity works, suggesting that the Council should endeavour to make the present electrical station meet the town's requirements for the next few years by taking in an additional store at the Beacon Quay. The proposal entirely upsets the Council's agreement with the Dolter Tramway Co., who would have to provide their own generating station and plant. The present station, with a capacity of 20,000 8-C.P. lamps, has already nearly 26,000 connected, and extension cannot be made without running the risk of legal proceedings from the adjoining householders; it is felt that very strong representations will have to be made to the Board with a view to sanction for the loan for a new station being obtained.

Weetslade.—On behalf of the Newcastle Electric Supply Co. a representative interviewed the Council recently and asked for permission to erect overhead H.T. mains for the supply of electricity in the district. The request was granted. In reply to a question, the representative said that if the large scheme was not completed in time for the Council's lighting season, the company would be prepared to erect a power station to supply the needs of the district.

Whitby.—An unopposed inquiry into the U.D.C.'s application for a loan of £1,500 for E.L. purposes was held on April 18th.

TRAMWAY AND RAILWAY NOTES.

Belfast.—Messrs. J. G. White & Co., the contractors for the conversion of the tramway system, are again hindered by labour troubles. On Friday last the paviours on the Shankill Road, Lisburn Road, and Shore Road sections struck for higher wages. The men working at 10d. per hour and 3d. per yard demand 1s. and 4d. respectively. The dispute has led to an almost complete cessation of the work. At present about 1,000 men are employed on the Lisburn Road, Ormean Road, Shankill Road, Duncaim Gardens—a new line—and the Woodstock Road will shortly be taken in hand. The foundations of the generating station on the Lagun Road have been laid.

Bexley Heath.—A loan of £5,000 for tramway purposes has been applied for by the U.D.C.

Blackpool.—The engineer, Mr. C. Furness, has just reported that he expects the electricity and tramways departments to relieve the rates of the town this year to the extent of £5,000, which has been made possible through economy in coal, equal to nearly £3,000, together with an increased output. The tramways of the Corporation have increased their receipts by £6,468, the number of passengers being 890,161, and the miles run 103,352. The total receipts were £47,796.

Dewsbury.—It is expected that a start will be made with the reconstruction of the steam tramways from Dewsbury to Batley, Birstall and Gomersal at an early date. The system is owned by the British Electric Traction Co. Arrangements have been completed with all the local authorities concerned except Batley Corporation. If there be no hitch it is hoped that the electric cars may be running on a portion of the track by the end of June or beginning of July. The present system is about four miles in length. When electrically-equipped, junctions will be effected with the Spen Valley system both at Dewsbury and at Gomersal.

Dundee, Broughty Ferry Tramways.—The power to construct and work these tramways was obtained by the Dundee, Broughty Ferry and District Tramways Co. in August, 1904. Mr. J. W. Speight is consulting engineer. The contract, which has been given to Messrs. J. G. White & Co., includes the complete construction and equipment of the permanent way, overhead gear, cars, power house, car-sheds, cables, &c., and the contract price is £88,250. There are 5½ miles of route, equivalent to 9¾ miles single track, of standard gauge. The rails are British Standard No. 1, 45 ft. long, fitted with continuous rail joints and intermediate anchors. The points are 10 ft. 6 in. long, with a radius of 100 ft. Crossings are iron-bound. One mile of the track will run on a new road through the Craigie and Home estates; this portion will be laid with the usual 6 in. bed of concrete, and paved with tar macadam and granite edging. The bridge over the Dighty will be widened. The overhead construction will be carried out mostly with bracket arms; there will be double trolley wire, 21 ft. from the ground. The cables are to be laid on the solid system. The power plant will consist of two 200-KW. dynamos coupled to high-speed engines. There will be three Lancashire boilers, superheaters, and the usual condensing plant. The car-shed will be a brick building, 176 ft. long and 45 ft. wide. The tracks in the car-shed will consist of Vignoles rails laid on sleepers. There will be 12 single-truck, double-decked cars fitted with two 37-H.P. motors, and we understand that Messrs. White propose to break the ground within a few weeks. They will also shortly commence work on the Dartford contract, which is similar to the Dundee Broughty Ferry undertaking with regard to length of track, construction and equipment.

Falkirk.—As a result of the introduction of the electric tramways into Falkirk and district, the question of the reconstruction of the bridge crossing the River Carron, near Carron Ironworks, has been under the consideration of the Falkirk T.C. and the Eastern District Committee of the Stirling County Council, who have each an interest in the bridge. The plans of a new bridge, to cost £3,700, have been approved by both bodies, subject to a proportion of the cost being sustained by the Carron Co. and the Falkirk and District Tramways Co. The Carron Co. offered to contribute £250 and an old wagon road running alongside the bridge, and belonging to them, on condition that the Tramways Co. contributed £750 as their share of the cost. The Tramways Co. agreed to this, subject to conditions, including the local authorities' consent to the proposed extensions of the tramways to Grangemouth and Laurieston, and the latter have agreed to accept the offer and proceed with the work.

Glasgow and Paisley.—An inquiry under the Private Legislation Procedure (Scotland) Act, 1899, will be held in the Justiciary Building, Glasgow, on May 5th to consider, among other orders, Paisley District Tramways and Glasgow Corporation Tramways Consolidation. The Commissioners are Mr. Eugene Wason, M.P. (chairman), Lord Stanley of Alderley, Sir John Batty Tuke, M.P., and Mr. Graeme Whitelaw.

Huddersfield.—The statement of income and expenditure of the tramway department of the Corporation, for the year ending March 31st, shows that the gross income has been £69,938, of which £67,252 represents passenger fares. Amongst the smaller sources of revenue is coal haulage, £271. The working expenses have amounted to £35,084, leaving a gross surplus of £34,854. Against this there are the charges for interest and redemption of debt and depreciation. The two former alone amount to £23,344. This leaves only £11,510 to meet depreciation at the rate of 3 per cent., which, on a capital outlay of £414,667, absorbs £12,013. On the year's working there is a deficit of £503, which, added to the debit balance carried forward from the previous year of £4,982, makes a total deficit to date of £5,485. It will be proposed to levy a rate of 3$\frac{1}{10}$d. in the £ to wipe off this adverse balance. In 1904 the rate in aid was 5d. in the £, and the year before 7d.

International Railway Congress.—According to a correspondent of the *Times*, the arrangements for the meeting of the International Railway Congress at Washington are now fairly complete. Monday next will be devoted to a very complete programme of inspection of various stations of steam and urban railways; Tuesday will be spent in Philadelphia, the inspection of the Baldwin Locomotive Works being the principal feature. The regular work of the Congress will begin on Wednesday. The programmes for the various tours cover practically everything of an interesting natural or engineering character from the Atlantic Coast to the Mississippi on the west and the St. Lawrence on the north. The British representatives will form by far the largest foreign delegation in the Congress. No effort is being spared to make the Congress successful from every point of view.

Liverpool—Southport Electric Railway.—On Easter Monday, for the first time, specially designed new coaches were used on the above line with very satisfactory results, greatly conveniencing the traffic. The new coaches have a special feature in that the passengers can reach the handle and open the door from the platform, without having to mount the steps of the carriage, as was the case under the late system of electric trains. The new door slopes outward, and is much easier to use than the old straight doors, and consequently the danger is greatly minimised. On Easter Monday 15,000 to 20,000 persons travelled on this line, and everything passed off without a hitch. The new pier electric tramway, which is nearly a mile long, and which is an entirely new feature, carried a large number of passengers, the pier being the longest on the west coast.

London.—Chelsea.—The Law and Parliamentary Committee of the T.C. reported last week that, as the opinion of counsel as to the rights of the municipality with regard to the notice served upon it by the London United Tramways, Ltd., preliminary to laying mains to the power station in Lots Road, was favourable to the Council, instructions had been given the borough solicitors, should the company insist upon opening the roadway, to apply at once for an injunction.

Luton.—The T.C. has applied to the B. of T. for an order authorising the construction of seven lines of electric tramways in the borough.

Manchester.—An estimate presented by the Tramways Committee to the City Council shows an anticipated traffic revenue for the coming year of £645,250, and miscellaneous revenue, including Salford's use of lines, rents, &c., £4,552; making a total revenue of £649,802, as compared with £638,775, the actual income for the year just ended. The latter amount falls short of the estimate by about £2,000. After meeting expenditure this year a balance, it is expected, will remain of £206,122, of which £49,560 will be set apart for payment of interest on loans, £38,795 for sinking fund and instalments of loans, £53,200 for renewals fund and permanent way, and £14,525 for depreciation, leaving a surplus of £46,000 to be transferred to the City fund in relief of rates, and £4,042 in respect of the infirmary site purchase. Last year the Committee gave £51,000 to the City fund, of which £46,000 consisted of surplus revenue, and £5,000 was taken from the contingent reserve fund. The working of the parcels carrying department (inaugurated at the beginning of this month) has been left out of the present account, as the Committee has as yet no data to go upon. On capital account the Committee proposes to spend this year a sum of £52,500. Of this £35,000 will be for cars and car equipments. In the year just ended the capital expenditure was £89,277, out of an estimated sum of £124,000.

Rochdale.—The accounts of the Rochdale Corporation Tramways for the financial year ended March 31st, show a loss of £8,358. There was a capital expenditure during the year of £273,814, including a sum of £70,832, Rochdale's share of the purchase price of the old undertaking. The loss is equivalent to a 3d. rate; but some of the most important sections of the undertaking have been working only three and six months.

Salford.—The Salford Tramways Committee contemplates extending its car-shed accommodation. When the lines were opened in November, 1901, the depôt in Seaforth Road was thought to be sufficiently commodious for all purposes. Since then, however, the system has grown, owing mainly to the Corporation having undertaken the working of the tramways in Whitefield, Eccles, Monton, Pendlebury and other outlying districts. The Seaforth Road depôt is to be extended by the construction of two large bays, for the accommodation of 30 or 40 more vehicles—making the total accommodation equal to about 220—and by the building of new offices for the administrative staff.

Sunderland.—The new tramway offices, built by the Corporation at an expense of £6,000, were formally opened on the 20th inst. The offices are a commodious set of premises conveniently situated, and admirably adapted for the purposes intended, having as well as adequate office space, accommodation for the men waiting for duty, &c. The chairman of the Committee, Councillor Thos. Summerhill, in formally opening the premises, said it was intended to pay for the building entirely out of revenue by instalments of £1,000 annually.

TELEGRAPH AND TELEPHONE NOTES.

Australia.—Last week's Australian mail brought the report of Mr. J. Hesketh, chief electrician attached to the Commonwealth Postal Department, who was appointed by the Federal Government to represent it at the St. Louis Congress, and examine the recent telegraphic developments in the United States and in Europe. Mr. Hesketh writes: "There is nothing in the American quad methods to lead Australia to adopt them, excepting the feature of dynamo supply." Further on, the expert recommends the adoption in the Commonwealth of the Yetman transmitter. Coming to England, Mr. Hesketh writes that in the G.P.O. of Great Britain is to be found the foremost telegraphic administration in the world. The double-circuit key, which operators in Australia say seriously affects their operating, and causes premature breakdown, is used exclusively in the British service on the double current circuit and without any complaint. Mr. Hesketh says he does not think the Pollak-Virag system would be suitable to Australian conditions, but the Murray page printer is a most promising automatic method so far as he has seen it. The inventor informed him that it would be about two years before the application of this system to Australian conditions would be advisable. Summing up the information gleaned, Mr. Hesketh makes the remark: "I regard as largely visionary the idea of using the telegraph as a means of transmitting ordinary correspondence. It is by no means a new idea, and wherever tried has failed. Even the practice of accepting 'deferred' messages at a lower rate and sending them after the ordinary day's work has been got rid of, has been abandoned in places where it has been tried, as New Zealand for instance." Mr. Hesketh recommends telephone lines as feeders to the telegraph system, Morse lines for other purposes, quad or duplex lines between busy centres, the Wheatstone automatic system for news work or congested traffic, sound reading and type writing to be regarded as essential adjuncts in all large offices, and telegraph switchboards to be used for regulating local traffic and obtaining economy of operating. A special report on wireless telegraphy is made by Mr. Hesketh. He assumes that the maximum distance over which communication will be required in Australia for some time is between Victoria and Tasmania. In his opinion a direct conclusive trial as to plant could be made at a small cost if a couple of stations were erected within the Commonwealth. Owing to the interference trouble, Mr. Hesketh emphasises the importance in introducing any wireless system into Australia of maintaining the absolute control of the Postmaster-General. Later on in his report, he adds that the opinion of independent engineers is in favour of wireless systems only where ordinary telegraphic communication is impracticable or unusually costly, as, for instance, to communicate with ships at sea or islands where the cable is subject to rapid deterioration by reason of a bad bottom. He utters a note of warning when he says that it is essential that the Postmaster-General should be protected against embarassing patent suits, as at the present time there is considerable controversy and also litigation on the subject of the real inventors of certain principal features or pieces of apparatus employed in various systems.

Bombay Telephones.—At the Bombay Telephone Co.'s meeting held at Bombay in March, it was stated that the company had concluded arrangements through the Oriental Telephone and Electric Co., Ltd., London, for the supply of cables for the first instalment of the new underground service, rendered necessary by

the conversion of the existing single lines into metallic circuits as required by the new Government license, and had contracted with the Callender's Cable and Construction Co., Ltd., of London, to lay the first section from the Fort to Colaba on the solid system. This work should be completed before next monsoon.

Canadian Telephones.—A special committee of the Canadian House of Commons has lately been considering the working of the public telephone systems of Canada and other countries, in regard to the comparative advantages of public and private control. Sir Wm. Mulock, the chairman of the committee, has outlined a scheme of his own, for bringing the telephone within reach of the public through apparatus to be established by the local municipalities. If the subject is not exhausted this session its inquiry will be continued next year. Mr. Maclean, of Toronto, suggested that an expert should be employed to prepare a special report on the municipal telephone system of Glasgow, and the telephone situation generally in the Old Country. Letters were read from certain towns saying that they were thinking of establishing municipal telephone systems, but were waiting to see what action the Government would take. It was decided by the committee to send a series of questions to all telephone companies in Canada, the United States and Europe, to ascertain the subscription rates, the cost and nature of the service, the profits and other particulars. The Toronto Corporation has asked the Government to take over the entire service of Canada.

Cape Town Telegraphs.—In the course of his report for the year 1904, Sir Somerset R. French, the Postmaster-General, incidentally states:—"During the year experiments have been made to test the feasibility of instituting and practically carrying out, simultaneous telegraphic and telephonic communication upon one and the same wire, and it has been found that with suitable arrangements it is entirely practicable to afford telephonic connection on single-wire branch lines to effect the purpose in view, and to open the same to public use so soon as the demand therefor arises." The total mileage of telegraph lines and wires on December 31st, 1904, was:—Lines, 7,966 miles; wires, 30,720 miles; underground cable, 4½ miles; aerial cable, 1¼ miles.

Lightning and the Telephone.—According to the *Birmingham Daily Post*, an extraordinary occurrence happened at Winchcomb on Sunday afternoon, during the passing over the town of a very heavy thunderstorm. The lightning struck and shattered an elm tree on the back premises of Mr. J. A. Oakey, builder, then, catching on the telephone wires running near, passed into the living room of Mr. Oakey. On reaching the instrument, an explosion like the firing of a cannon occurred, and the room was filled with smoke. The wires were torn down and melted, and the instrument and other articles were scattered about the room, the wires burning holes in everything they came in contact with. The only thing that remained intact was the conductor, which should have conveyed the discharge to the ground. One of Mr. Oakey's daughters was passing the instrument at the time, and had a miraculous escape. She met the flame and smoke and *débris*, had several holes burnt in her dress, and one hand slightly cut. The rest of the family were in the sitting room at the time, or the affair might have been more serious.

Rosario Telephones.—The *South American Journal* reports the formation of the Co-operative Telephone Co., of Rosario. Mr. Pedro Lopez, ex-chief of National Telegraphs, is to be manager. Tenders are shortly to be invited for the supply of the necessary material.

Telegraphists' Grievances.—The annual conference of the United Kingdom Postal Clerks' Association, held at Reading on Monday, expressed its "unqualified dissatisfaction with the proposals of the Postmaster-General respecting the scales of pay to the Post Office workers," and pointed out "that these concessions, which have not been granted spontaneously, are considerably less than the recommendations of the Bradford Committee, an inquiry by impartial and expert business men, appointed by the Postmaster-General himself, and granted only after years of agitation." It expressed its dissatisfaction "at the brushing aside by the Postmaster-General of the findings of that Committee, and pledged itself to use every effort to obtain the ameliorative recommendations of the Bradford Committee as a minimum concession."

Telegraph Deficit.—According to a recent Parliamentary return, the total receipts from the telegraphic service for the year ending March 31st, 1904, were £3,736,114, and the expenditure £4,693,897. The deficit for the year was, therefore, £957,783, as compared with £601,711 in the previous year. The total deficiency since the purchase of the Telegraphs, now amounts to over 12 millions sterling.

The Telephone Purchase.—In the House of Commons last week, Lord Stanley stated that he had met the views of members who objected to the constitution of the Select Committee to consider the Telephone Agreement, and he hoped the matter would not be treated as controversial. He was anxious that the motion to appoint the Committee should be agreed to as soon as possible.

Lord Stanley received a deputation at the Post Office, and intimated that, although he could not promise any particular individual in the employment of the National Telephone Co. that he would be taken on the G.P.O. staff, still he could safely promise that the telephone staff collectively would be employed under the new conditions. The Government pensions could not commence until the telephone employés had actually joined the P.O. service, but those telephone employés taken over, would not have to wait ten years before the pension started, as was the case when the present P.O. employés entered the service.

On the recommendation of the Parliamentary Committee, the L.C.C. has agreed that the maximum rate fixed by the agreement of 1901, between the Postmaster-General and the National Telephone Co. should be reduced; that Clause 4 (1) of the new agreement be amended so as to make it clear that no addition shall be made to the value of items, other than "plant" of the company's undertaking, in respect of compulsory purchase, and that the Parliamentary Committee be authorised to endeavour to obtain such further modification of the proposed terms of purchase in the interests of the telephone users of London, as may be desirable.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1)	Aug. 26, 1901	..
Dominica-Martinique	May 7, 1902	..
St. Lucia-Martinique	May 7, 1902	..
Cayenne-Pinheiro	Aug. 18, 1902	..
Beissa-Issa (Yemen) Camaran	Oct. 22, 1902	..
Tarifa-Tangier	Jan. 18, 1904	..
Closed { Vladivostok-Nagasaki	Feb. 9, 1904	..
Closed { Port Arthur-Chifu	Mar. 9, 1904	..
Jamaica-Colon	Jan. 5, 1905	..
Martinique-Paramaribo	April 2, 1905	..
Pernambuco-Para	April 6, 1905	April 22
Maranham-Ceara	April 6, 1905	..
Assab-Massowah	April 17, 1905	April 20
Falmouth-Bilbao	April 19, 1905	April 20
Bathurst-Bissao	April 22, 1905	..
Landlines.		
Puerto-Barrios	July 28, 1902	..
Kerich-Soutehoum	Sept. 27, 1904	..
Bhamo route beyond Tali	Jan. 15, 1905	..
Newfoundland—all places in the interior	Feb. 10, 1905	..

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—The Municipal Authorities of Ischl (Tyrol) are about to invite tenders for the construction of a central electric lighting station in the town.

Cork.—The Cork Electric Tramways & Lighting Co. invites tenders for whitewood casing and capping. See "Official Notices" April 21st.

Dublin.—May 15th. The Dublin Port and Docks Board is prepared to receive tenders for an electric generating station. Apply to Mr. John P. Griffith, M.Inst.C.E., East Wall, Dublin, for specifications &c., (deposit £5).

Edinburgh.—May 8th. Water-tube boilers for the electricity works. See "Official Notices" April 14th.

France.—May 14th. Tenders are being invited until May 14th, by the municipal authorities of Dax (Landes) for the concession for the electric lighting of the town during a period of 35 years. Tenders are to be sent to La Mairie de Dax (Landes), whence particulars can be obtained.

France.—May 15th. The Governor General of French West Africa, at Dakar (Senegal), is inviting tenders for the establishment of a central electricity station in the town, and for the construction of an electric tramway.

Holland.—May 6th. Tenders are being invited until May 6th by the Municipal Authorities of Utrecht, for the supply and erection of the overhead conductors required in connection with the electric tramway system in Utrecht.

Hungary.—The town of Debreczen, in Hungary, is inviting tenders for the erection of a central electric light and power station. The town has 70,000 inhabitants.

Johannesburg.—May 7th. Tramway poles, feeder pillars, overhead material, telescopic ladders, motor tower wagon, &c. See "Official Notices" March 17th.

London.—May 16th. The L.C.C. invites tenders for the erection and maintenance, for a period of 10 years, of a battery of 280 accumulator cells, having capacities of 645 ampere-hours at a 3-hour discharge rate, and of 450 ampere-hours at a 1-hour discharge rate. See "Official Notices" April 21st.

Portsmouth.—May 1st. Tramway stores for the Corporation. See "Official Notices" April 14th.

Rosario.—July 31st. The *Review of the River Plate* says that one of the alterations in the new electric tramways specification is the date for sending in tenders, which is now to be July 31st.

Spain.—May 3rd. Tenders are being invited by the Municipal Authorities of Baeza (Jaen province) until May 3rd, for the concession for the electric lighting of the town during a period of 10 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Baeza (Jaen).

Warrington.—May 13th Condensing plant for the electricity works. See "Official Notices" to-day.

(*Continued on page* 695.)

THE BIRMINGHAM AND MIDLAND TRAMWAYS.

The Birmingham and Midland Tramways and Light Railways comprise an extensive network of routes lying round the city of Birmingham, and connecting up the latter to West Bromwich, Wednesbury, Wolverhampton, Dudley and Stourbridge. These lines are owned by the Birmingham and Midland Tramways, Ltd., the City of Birmingham Tramways Co., Wolverhampton District Tramways Co., and the South Staffordshire Tramways (Lessee) Co., and are controlled by the Birmingham and Midland Tramways Joint Committee, the total route length being 114 miles.

Fig. 1.—Smethwick Power Station and Offices.

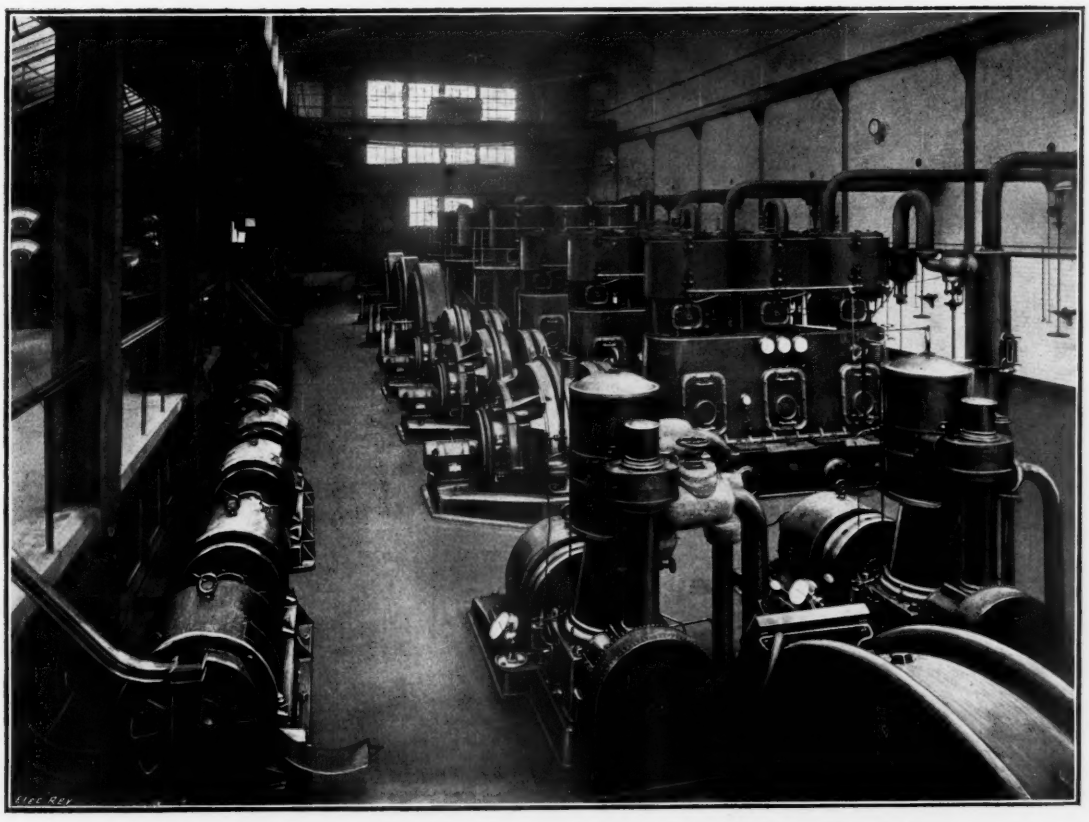


Fig. 2.—Interior of Engine House: Traction Generators, Balancers, Exciters, &c.

The present article deals with the electrification of the 11·8 route miles comprising the Birmingham and Midland Tramways, Ltd., fig. 8, which start in the city of Birmingham, near the municipal buildings, and extend through Smethwick, Oldbury and Rowley Regis into Dudley; the route being double-track for about half the distance, and single-track with turnouts over the remainder.

Branch lines are situated inside Birmingham, traversing Heath Street to the Smethwick boundary, this line being single-track with turnouts, and in Cranford Street, Smethwick, where double-track is laid; from Windmill Lane, in Smethwick, to the Harborne boundary (double-track), and a loop-line of single-track with turnouts, running from West Smethwick through West Bromwich and rejoining the main route in the Market Square, Oldbury.

The permanent way inside the Birmingham area is laid with rails weighing 102 lb. per yd., this work having been carried out to the specification and under the supervision of the city engineer.

The two new routes in Cranford Street and in the

Bearwood and Waterloo Roads were laid with 96-lb. rails, the contractor being Mr. George Law, and the work on the remaining portions was carried out by the Tramways Co. itself, under the supervision of Mr. R. W. Cramp.

Inside the Birmingham area the overhead equipment has been carried out with bracket-arm construction, taper poles supplied by Messrs. James Russell & Co. being used on each side of the main route, with occasional span wires, however, at very wide points, and centre poles in the vicinity of the Free Library in Dudley Road. On the Heath Street route, side poles on one side only are used, except at loops and crossings, where poles and bracket arms are placed on both sides of the street.

Outside the city span wire construction is chiefly used, with bracket arms in the narrower streets, and there the steel poles are in three sections, and were supplied by Messrs. Spencers, of Wednesbury. The trolley wire inside the city is No. 00 gauge, and outside, No. 0 A.W.G. On account of the heavier traffic in the busy routes from the municipal boundary to Windmill Lane, the feeding points are ¼ mile apart; outside this area they are ½ mile apart. Standard B.E.T. feeder pillars are used on the routes outside the city, and pillars of Messrs. Callender's make on the city lines.

Fig. 3.—H.T. Three-Phase Switchboard.

The old steam car depôt at West Smethwick has been added to and partly rebuilt to provide accommodation for an increased number of electric cars, the site being sufficiently large to permit of a further extension of the buildings, which would make the holding capacity of the shed, 100 cars. A view of the shed, including the old water tower, used for supplying the superseded steam cars, is shown in fig. 7.

The cars, of which some 70 are on order, are made by the Brush Electrical Engineering Co., at Loughborough, and 42 have already been delivered. Eighteen of these are fitted with standard Brush trucks,

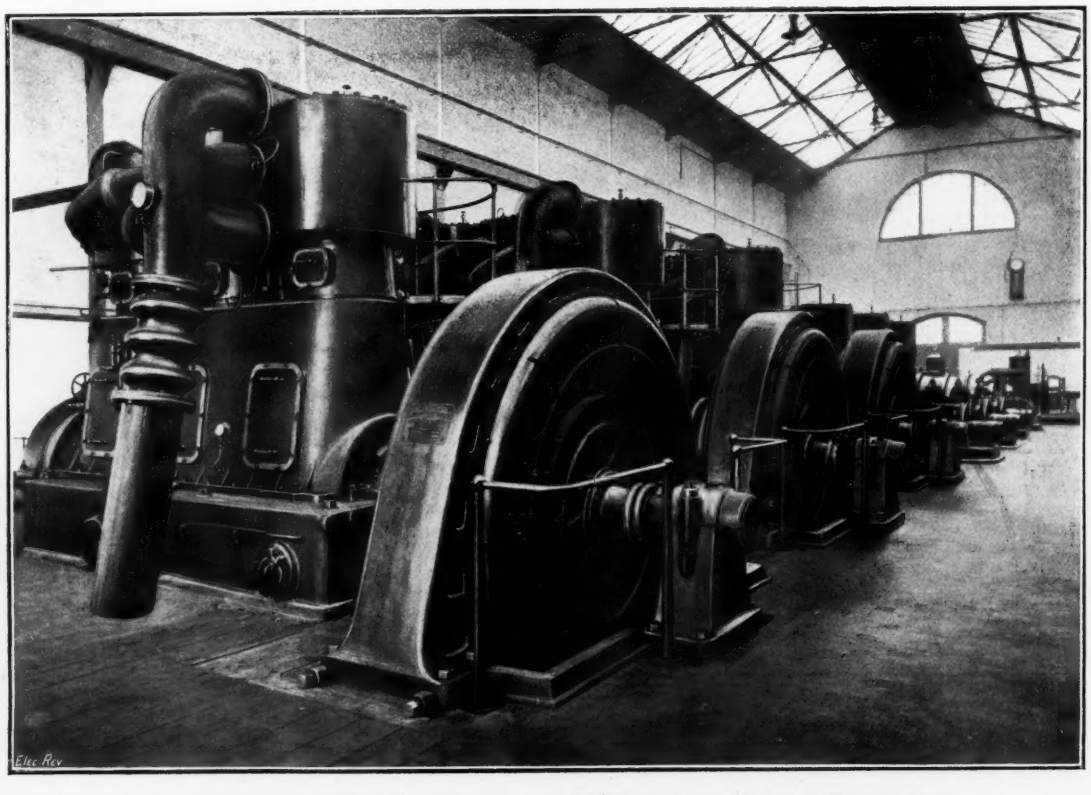


Fig. 4.—Interior of Engine House: Brush-B.T.H. Three-Phase Plant in Foreground.

and 22 with Lycett and Conaty radial trucks. The wheel base of the Brush trucks is 6 ft. 6 in., and of the radial trucks 8 ft. 6 in. The bodies are 16 ft. long, and the total length between buffers is 28 ft.; they have a seating capacity of 22 inside, and 26 outside. Twelve of the cars have been fitted with Bellamy top-deck covers supplied by Messrs.

Fig. 5.—View inside Boiler House.

Dick, Kerr & Co., and on these cars Blackwell trolley bases are in use, but the open cars have been fitted with Brecknell, Munro & Rogers' standards. On all the cars, Rowland's swivelling trolley heads, supplied by Messrs. Milnes, Voss and Co., are used.

The life-guards are of the Brush trigger type, and to enable the guard to work efficiently, folding steps are fitted to all the cars.

The equipment consists of Brush B 1,002 motors rated at 33 B.H.P., and the controllers are of the B.T.-H. B 18 type.

A certain number of the cars are also equipped with the Raworth regenerative system of control, with which our readers are familiar.

The power station, an outside view of which is shown in fig. 1, is situated in Downing Street, Smethwick, on the banks of the Birmingham Canal. It is designed to supply not only the tramway routes mentioned, but also the Smethwick area, with energy for power and lighting; the company owning the provisional order for this district. We may here mention that in the immediate vicinity of the power station are situated many large industries, including such well-known firms as Tangyes; Averys; Guest, Keen & Nettlefolds; Evered & Co.; Birmingham Patent Iron & Brass Tube Co.; Allen, Everett & Sons; the Patent Rivet Co., &c., certain of whom are negotiating for large power supplies at the present time, and, as the company has arranged a very business-like power tariff, ranging from 1·32d. to ·86d. per H.P.-hour, with varying load factors, the prospects in this direction appear very promising.

The tramway routes are supplied through rotary converter sub-stations situated at Oldbury and Springhill (Birmingham), these being 4 and 3 miles distant from the power station respectively, the routes in the immediate vicinity being supplied direct at low-pressure from the power station.

The power station buildings are constructed of steel and brickwork, the latter being of local bricks, relieved with rubbed and ganged arches.

The dimensions of the main buildings are as follows:—Engine house, 152 ft. long × 45 ft. wide, 47 ft. 6 in. high; boiler house, 152 ft. long × 50 ft. wide, 40 ft. high.

The boiler house roof and the width of the building are only temporary, as the engineer's original design was for a building sufficiently wide to take two rows of boilers with a central stokehole between. The coal storage was arranged on the floor above the pump room, from which the coal would be delivered through shoots into the hoppers of the chain grate stokers below; this arrangement, however, was abandoned on the score of economy, but will have to be reverted to in the event of any considerable demand arising for energy from the station.

In the station buildings are also pump rooms, repair shops, engineers' offices, bath rooms, lavatories, workmen's mess rooms, stores, &c.

The manager's and general offices are in a handsome detached building fronting on to Downing Street, and equipped with modern conveniences.

The whole of the building work has been carried out by Messrs. Gowing & Ingram, contractors, of Birmingham, to plans and specifications prepared by Mr. M. H. Graham, architect, of Newcastle-on-Tyne.

The same contractors were responsible for the transforming sub-stations, and these also are of plain hand-picked local bricks in cement mortar, but lined throughout with white and buff-coloured glazed bricks, with a dado border in chocolate.

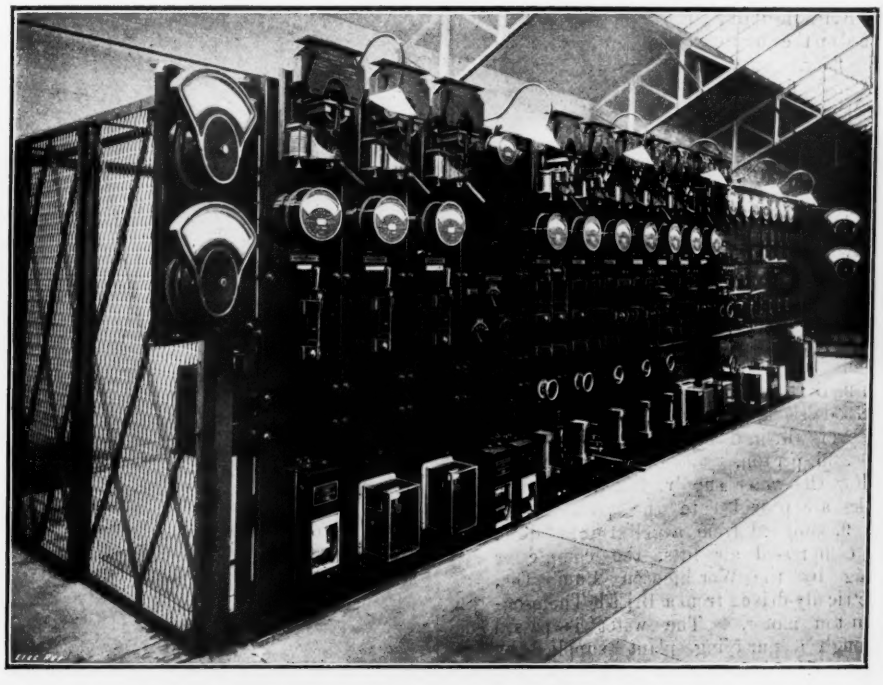


Fig. 6.—Direct Current Traction and Lighting Switchboard.

The steam-raising plant consists of five Babcock & Wilcox water-tube boilers, fig. 5, constructed for a working pressure of 160 lb. per sq. in. and capable of evaporating 14,000 lb. of water per hour; each boiler having 3,580 sq. ft. of heating surface. They are fitted with the same firm's chain grate stokers and internal superheaters—the steam being superheated 150° F.

Fig. 7.—Car Depot: West Smethwick.

The line shaft for working the mechanical stokers is driven through worm gearing by a 15-H.P. motor, placed on the pump-room floor.

A main flue runs the length of the boiler house, under the boilers and pump room to the chimney; the latter is of steel, 120 ft. high and 11 ft. in diameter; it stands on a concrete foundation 34 ft. sq. and 14 ft. deep, and is lined with firebrick for 75 ft.

A Green economiser of 256 tubes is arranged in the main flue beneath the pump room, the scrapers being operated by a 3-H.P. Brush motor.

Good slack coal is the fuel used, the price of which, delivered into the bunkers, is 6s. 3d. per ton.

For the water supply, feed and storage tanks are provided in the pump room, fig. 9, supplied from a well 180 ft. deep, by compressed air lifts, the compressor being by the Worthington Pump Co., electrically-driven from a British Thomson-Houston motor. The water is passed through a purifying plant supplied by Messrs. Harris & Anderson, which also is installed in the pump room, together with three feed pumps, two of them being supplied by Messrs. J. & G. Weir, with rated capacities of 3,500 and 2,540 gals. per hour respectively, and the other, a variable-stroke motor-driven pump of Messrs. Mather & Platt's make, has a capacity of 6,000 gals. per hour.

The feed piping is arranged for drawing from the feed tank, through a Kennedy water meter and pumping *viâ* either of two Rankine feed water filters and the economiser to the boilers or direct to the boilers if the economiser should be shut down.

An alternative water supply is provided from the South Staffordshire Water Co.'s mains.

The steam and feed piping is of mild steel, supplied by Messrs. John Spencer, Ltd., of Wednesbury, and was erected by the tramways company's staff; it is covered with blue asbestos supplied by the Cape Asbestos Co.

The exhaust pipes, which are of cast-iron, are liberally fitted with expansion joints.

In the engine house, which is spanned by a 20-ton Vaughan travelling crane, there are installed six generating sets; three 500-KW. three-crank triple-expansion self-lubricating engines, running at a speed of 300 r.p.m., the diameter of the cylinders being 15½, 23 and 35 in., with 15 in. stroke, and three three-crank compound engines, each of 300-KW. capacity, with one high-pressure and two low-pressure cylinders, of 16½, 23 and 23 in. diameter × 10 in. stroke, direct coupled to B.T.H. three-phase alternators and Brush D.C. generators respectively.

The engines are fitted with governors of the inertia shaft type, guaranteed to control the speed within a variation of not more than 3½ per cent. from full load to no load.

Both engines and generators are specified to be capable of withstanding an overload of 25 per cent. for half an hour, and 50 per cent. momentarily, over and above the normal rating.

The steam consumption per I.H.P.-hour for the 500-KW. sets, with 150 lb. steam pressure, 100° F. superheat at the stop-valve, and 26 in. vacuum, was specified not to exceed 14¾ lb. on

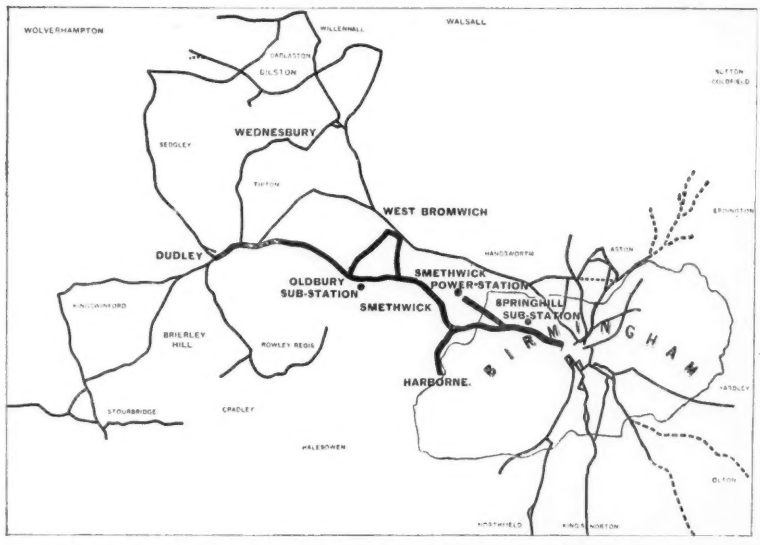


Fig. 8.—The Birmingham and Midland Tramways and Light Railways.

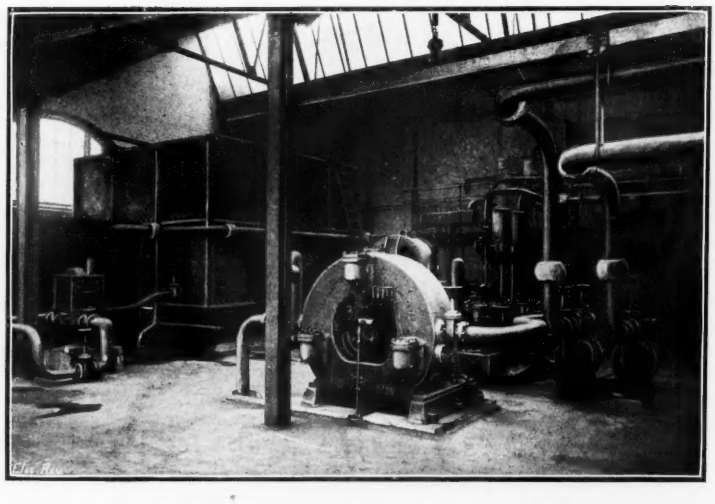


Fig. 9.—Power House: View of Pump Room.

500-KW. output, 13¾ with 450 KW., and 15 lb. with 225 KW.; the mechanical efficiencies of the engines under these conditions being respectively 91, 90 and 84 per cent.

For the 300-KW. sets, the steam consumption per I.H.P.-hour at the same pressure, vacuum and superheat as previously, was specified not to exceed 15 lb. at 300 KW. output, or 16½ lb. at 225 KW., the mechanical efficiencies of the engine, under these conditions, being respectively 91 and 84 per cent.

These conditions were satisfactorily met on test at the Brush Electrical Engineering Co.'s works at Loughborough, where the engines were built.

The alternators were supplied by the British Thomson-Houston Co., of Rugby, and are of the revolving field type, each of 500 KW. capacity, generating three-phase current at 25 cycles and at 5,000 to 5,500 volts, while the three direct-current generators are eight-polar machines of 300 KW. nominal capacity, running at a speed of 375 r.p.m, and were made by the Brush Electrical Engineering Co.

(To be concluded.)

CONTRACTS OPEN AND CLOSED.

(Continued from page 690.)

CLOSED.

Barnsley.—The T.C. has accepted the tender of Messrs. Arnold & Co. for the supply of a boiler and mechanical stokers to the electricity works, at £789 10s.

Bedwellty.—The B.G. has accepted the tender of Messrs. Edwards & Armstrong, of Bristol, for the supply of electrical generating and storage plant for the Workhouse.

Cardiff.—Messrs. Edwards & Armstrong, of Bristol, have secured the contract for installing 3,000 electric lights and 100 inter-communication telephones at the new Town Hall and Law Courts at Cardiff.

Doncaster.—The Electricity Committee has accepted the tender of Messrs. Belliss & Morcom for the supply of an engine, and that of Messrs. Babcock & Wilcox for a boiler, complete with chain-grate stoker and superheater.

Hammersmith.—The B.C. has received the following tenders:—

BOILER FLUES AND ECONOMISER.

	Flues and forced draught.	Economiser and settings.
J. Howden & Co. (accepted for flues and forced draught apparatus)	£1,228	£540
E. Green & Sons (accepted for economiser)	1,260	560
A. Lowcock, Ltd.	1,260	523
Pollock, McNab & Highgate	1,260	875
J. Spencer & Co.	1,282	525
Rosser & Russell	1,324	520
Davey, Paxman & Co.	1,848	—
J. Carter & Co.	—	1,245

For the piping section there were 16 tenders, and that of Messrs. Aiton & Co. was accepted, at £1,393.

HIGH AND LOW PRESSURE WATER VALVES.

J. E. & S. Spencer	£665 9 6
G. M. Marchant	721 8 6
J. E. & S. Spencer	782 0 0
Templer & Rance	794 13 2
	749 9 2
Hill, Mason & Co.	753 0 0
	864 6 0
	637 16 0
	590 0 0
Aiton & Co. (accepted)	763 16 0
Babcock & Wilcox	840 12 6
Rosser & Russell	855 0 6
Davey, Paxman & Co.	880 0 0
Worthington Pump Co.	891 11 6

FEED-WATER HEATERS.

Pollock, McNab & Highgate	£220 0
Baker's Patent Appliances, Ltd.	300 0
I. Storey & Co.	360 0
J. Wright & Co.	443 0
G. M. Marchant	447 0
J. E. & S. Spencer	416 0
J. E. & S. Spencer	456 16
Worthington Pump Co. (accepted for one "Webster," at £234)	468 0
W. Boby & Co. (accepted for one "Chevalet-Boby Heater "Detartariser," at £243)	486 0
Rosser & Russell	537 0
Paterson Engineering Co.	575 0
Lawrence Patent Water Softener Co.	575 0
Sir Hiram Maxim Electrical Engineering Co., Ltd.	975 0

The tender of G. & J. Weir for two feed water pumps, at £108 each, has been accepted, also that of the Universal Electrical Manufacturing Co. for the annual supply of arc lamp accessories.

Gillingham (Kent).—The Education Committee has accepted the tender of Mr. W. Parker, of Gillingham, for installing the electric light at the Napier Road School, at £95. There were six tenders, the highest being £295.

Glasgow.—The Stores Committee of the Corporation Tramways has recommended for acceptance the tender of the Scottish Vacuum Cleaner Co., Ltd., for a dust extractor for electrical plant.

Hanley.—The T.C. has accepted the tender of Mr. G. Saxon, of the Openshaw Engineering Works, Manchester, for the repairs to the engines at the Electricity Works, at £227.

Hull.—The Corporation Telephone Committee has accepted the tender of the Electrical Co, Ltd., of London, for the supply of cables, at £3,374.

Johannesburg.—The Tramways and Lighting Committee has recommended the acceptance of the tender of Messrs. Dick, Kerr & Co., Ltd., for 100 electric cars, two watering carts, &c., at £65,693, plus £16,624 for transit charges. Twenty cars are to be provided with canopies, at £127 extra per car. The Committee has also recommended the acceptance of the tender of Mr. E. Stein, to erect generating station and offices, at £42,062.

London.—The London County Council has accepted the tender of Messrs. Ward Bros, amounting to £130, for the wiring and fittings at Rotherhithe fire brigade station. Other contracts which have recently been decided are as follows:—

EIGHT INDUCTION MOTOR-GENERATORS FOR SUB-STATIONS.

Bruce Peebles & Co., Ltd. (not to specification)	£12,800 0
Electrical Co., Ltd. (not in order)	14,364 0
Dick, Kerr & Co., Ltd. (accepted)	14,747 10
Do. (alternative)	13,660 0
Electric Construction Co., Ltd.	14,940 0
General Electric Co., Ltd.	15,491 0
Brush Electrical Engineering Co., Ltd.	15,590 0
British Westinghouse Co., Ltd.	16,329 0
Do. (alternative)	15,917 0
Phœnix Dynamo Manufacturing Co., Ltd.	17,187 0
Siemens Bros. & Co., Ltd.	17,415 15
Do. (alternative)	15,986 15
British Thomson-Houston Co., Ltd.	17,934 0
British Electric Plant Co., Ltd.	18,728 0
Johnson & Phillips	19,817 0

LOW-TENSION CABLES FOR GREENWICH STATION.

W. F. Dennis & Co.	£2,151 3 6
Johnson & Phillips (not to specification)	2,214 13 1
Western Electric Co. (accepted)	2,232 4 9
British Insulated & Helsby Cables, Ltd.	2,438 17 6
St. Helens Cable Co., Ltd.	2,446 11 8
Siemens Bros. & Co., Ltd.	2,465 8 7
W. T. Glover & Co., Ltd.	2,523 11 9
W. T. Henley's Telegraph Works Co., Ltd.	2,553 10 0
Callender's Cable & Construction Co., Ltd.	2,595 1 0
Edison & Swan United Electric Light Co.	2,701 8 10

WIRING MATERIAL FOR GREENWICH STATION.

Conduits & Fittings, Ltd., London (accepted)	£1,407 0 0
General Electric Co., Ltd.	1,418 13 11
Armorduct Manufacturing Co., Ltd.	1,423 14 9
Edison & Swan United Electric Light Co., Ltd.	1,424 16 0
William McGeoch & Co., Ltd.	1,480 0 9
Simplex Steel Conduit Co., Ltd.	1,697 11 11
Veritys, Ltd., London (incomplete)	1,144 4 0

Six tenders have also been considered for the supply of lamps for the Stores Committee and for the tramcars, that of the General Electric Co., at £662 10s., being accepted.

FORTHCOMING EVENTS.

Monday, May 1st.—At 5 p.m. Royal Institution. Annual Meeting.

Thursday, May 4th.—At 5 p.m. Royal Institution. "Flame," by Prof. Sir J. Dewar. (Lecture I.)

At 7.30. Civil and Mechanical Engineers' Society. Annual General Meeting.

At 8 p.m. Institution of Electrical Engineers, at Society of Arts. Re-discussion on Mr. A. M. Taylor's paper, on "Stand-by Charges and Motor Load Development," read before the Birmingham Section in December last.

At 8 p.m. Chemical Society Meeting.

Friday, May 5th.—At 8 p.m. Junior Institution of Engineers. Mr. J. N. Boot, on "Condensing Plant."

Saturday, May 6th.—At 8 p.m. Electrical Engineers R.E. (Vols.). Last Concert of the Season, at Caxton Hall. Col. R. E. B. Crompton, C.B., in the chair.

THE ELECTRICAL ENGINEERS R.E. (VOLS.).

The following orders have been issued for next week:—

Monday, May 1st.—"A" Company. Recruits' Drill, 6 p.m. Drill Order Parade at 7 p.m. Technical Instruction, 8 p.m.

Tuesday, May 2nd.—"B" Company. Instructional Drill, 7 p.m. Technical Instruction, 8 p.m. Medical Inspection for Recruits and Special Service Section, 7 p.m.

Wednesday, May 3rd.—Adjutant's Drill at Millbank Barracks. Parade at Headquarters, 7 p.m. Drill order.

Thursday, May 4th.—"C" Company. Company Drill. Parade at Headquarters, 7.45 p.m. Rifles and side arms. Plain clothes.

Friday, May 5th.—"D" Company. Recruits' Drill, 6 p.m. Drill Order Parade at 7 p.m. Technical Instruction, 8 p.m.

Saturday, May 6th.—Bohemian Concert at "Caxton Hall," 8 p.m.

J. J. F. O'SHAUGHNESSY, Captain E.E.

For O.C.E.E.R.E. (V.

NOTES.

Incorporated Municipal Electrical Association.—The Tenth Annual Convention of this Association is to be held at Edinburgh and Glasgow, from June 27th to 30th, 1905. The Association headquarters will be at the North British Railway Hotel, Princes Street, Edinburgh. The following is a preliminary programme of the meeting:—

First day, Tuesday, June 27th, Edinburgh.
Morning—Presidential address. Reading and discussion of papers.
Afternoon—Visits to electricity works.
Evening—Reception by the Lord Provost, Magistrates and Council.

Second day, Wednesday, June 28th, Glasgow.
Morning—Reading and discussion of papers.
Afternoon—Visits to electricity and other works.

Third day, Thursday, June 29th, Edinburgh.
Morning—Reading and discussion of papers.
Evening—Members' annual dinner.

Fourth day, Friday, June 30th, Edinburgh.
Morning—Annual general business meeting (members only).

The following are some of the subjects to be discussed during the Convention:—1. Load factor—its effect upon an electricity station; 2. Street lighting; 3. Extensions to outlying areas; 4. Free wiring and supply on the prepayment system; 5. Allocation of costs; 6. The supply of electricity in industrial areas, from a municipal point of view. All communications should be addressed to the Secretary, Mr. C. McArthur Butler, Staple Inn Buildings, Holborn, London, W.C.

Institution Notes and Lectures.—Before the last meeting of the Ipswich Engineering Society, Mr. R. Marrack read a paper on "Losses in Factory Power Practice."

The Council of the Institution of Civil Engineers has made the following awards for papers read and discussed before the Institution during the past session:—Telford Gold Medals to Lord Brassey, K.C.B., and Mr. C. S. R. Palmer; a George Stephenson Gold Medal to Mr. Lyonel E. Clark; a Watt Gold Medal to Mr. J. F. C. Snell; Telford Premiums to Messrs. L. F. Vernon-Harcourt, M.A., R. W. Allen and Wm. Marriott; a Crampton Prize to Mr. A. Wood-Hill; and the Manby Premium to Mr. E. D. Pain. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

At the annual meeting of the Institution of Civil Engineers, held on Tuesday last week, Sir Guilford Molesworth, K.C.I.E., President, in the chair, the result of the ballot for the election of officers was declared as follows:—President, Sir Alexander Binnie; Vice-Presidents, Dr. Alexander B. W. Kennedy, Mr. W. R. Galbraith, Mr. William Matthews, C.M.G., and Sir Leader Williams; other members of Council, Col. W. P. Anderson (Ottawa, Canada), Mr. N. Napier Bell (New Zealand), Mr. B. Hall Blyth, M.A. (Edinburgh), Mr. C. A. Brereton, Mr. R. Elliott-Cooper, Col. R. E. B. Crompton, C.B., Mr. W. J. Cudworth (York), Dr. G. F. Deacon, Dr. F. Elgar, Mr. Maurice Fitzmaurice, C.M.G., Mr. R. A. Hadfield (Sheffield), Mr. G. H. Hill, Mr. C. W. Hodson, C.S.I., Mr. J. C. Inglis, Mr. G. R. Jebb, Sir William Thomas Lewis (Aberdare), Mr. A. G. Lyster (Liverpool), Sir Charles Metcalfe (Cape Town), Sir Andrew Noble, K.C.B. (Newcastle-on-Tyne), the Hon. Charles A. Parsons, C.B. (Wylam-on-Tyne), Mr. A. Ross, Mr. A. Siemens, Mr. John Strain (Glasgow), Sir John I. Thornycroft, Prof. W. C. Unwin, B.Sc., and Mr. A. F. Yarrow.

A visit of members of the Rugby Engineering Society to the power station of the London Underground Electric Railways Co., at Lot's Road, Chelsea, has been arranged for Saturday afternoon, May 20th. Members have to hand in their names to the secretaries before May 6th.

Appointments Vacant.—The London County Council is wanting a resident engineer (£8) and an assistant resident engineer (£5) for temporary appointments connected with the tramways branch of the Tramways Department; borough electrical engineer and tramway manager for Southend (£400); man experienced in overhead line work and car erection, for Lancaster Corporation (£2); shift engineer for Sheffield tramways power station (£130).

Gas.—A gas explosion occurred at Birmingham on 21st inst. and blew out the front of a bedstead factory, the entire four floors also collapsing in consequence. Four persons were more or less seriously injured. An escape from the 3-in. main supplying the gas engines was the cause.

On Wednesday morning a serious gas explosion occurred at Lavender Hill, Battersea, leakage from a chandelier being the cause. Two persons were injured, one seriously.

British Motor-Boat Club.—Admiral Sir William Kennedy, K.C.B., Commodore of the British Motor-Boat Club, will be in command, for him, of a novel fleet of vessels on May 6th, on the occasion of the opening meeting of the club at Kingston-on-Thames. The fleet of motor-launches will take a run up and down the river about 4 p.m., returning to the Sun Hotel, Kingston-on-Thames, in time for dinner. This club is arranging races for motor-boats at all the important regattas round the coast, and, where possible, on the rivers. Headquarters have been fixed up at the Craven Hotel, Craven Street, Strand, where the club will move on May 1st.

Precautions against Fire on Underground Railways.—The Fire Brigade Committee of the L.C.C. recently reported that an arrangement had been arrived at with the Board of Trade in regard to the procedure to be adopted for dealing with communications to and from promoters in respect of fire extinguishing appliances on underground electric railways. It had been arranged that when the promoters had obtained Parliamentary powers the Board would serve upon them its requirements as regards fire precautions, and also the minimum requirements suggested by the County Council. The Board would also call upon the promoters to furnish the Council with plans in duplicate of the railways and stations (above and below ground), showing the fire hydrants and other fire appliances proposed to be provided. On receiving the plans the Committee intended to obtain reports from the chief officer, and its decisions and any other requirements thought necessary would be communicated to the Board, which would then deal with the promoters in each case. A final expression of opinion as to the sufficiency of fire appliances would, of course, not be given by the chief officer or the Council until the completion of the railways. When railways constructed in accordance with the Board's requirements were finished, and the fire appliances were actually installed, the chief officer would inspect them, and submit his opinion to the Committee, and a copy would be forwarded to the Board of Trade. The Committee had agreed that inquiries on the subject of fire appliances might be addressed by promoters to the County Council, and the latter would reply to such of those inquiries as raised questions respecting the interpretation or explanation of the requirements.

The Council postponed formally a proposal to expend £5,513 on the construction of a short length of overhead trolley line along the Archway Road to the county boundary at Highgate Archway. It was proposed to lease the lines to the Metropolitan Electric Tramways Co. for a period of three years at a rent of £1,500 for the first year, £2,000 for the second, and £2,500 for the third year, the company to provide the rolling stock and power.

Municipal Contracting.—At a meeting of the Sheffield Board of Guardians on April 19th, a letter was read from the Secretary of the Sheffield Electrical Contractors' Association asking for the list of firms who had tendered for the electric light mains at the hospital and the prices quoted, as he had reason to believe that the Sheffield Corporation E.L. Department, whose tender at £72 10s. had been accepted, had tendered below cost price. The Board declined to accede to the request.

Telephone Exchange Fire.—At the resumption of the inquiry last week, Mr. C. B. Clay gave further evidence to the effect that no user of the company's telephone service had been injured by lightning. Signalman Doyle, of the District Railway Co., said that at 1.39 a.m. on February 8th he saw a bright arc on the up line, which burned for about 10 minutes, and at 2 a.m. a similar thing occurred on the down line. Mr. Bennett said the telephone cables should be at a distance from the power cables, and should not be in iron troughs. Protecting devices should be provided at all exchanges and on all subscribers' premises.

Mr. Gaine, general manager of the National Telephone Co., described the roundabout procedure necessary to get into communication with the Fire Brigade, and Lieut. Sladen said he thought the latter knew its own business best. Lieut.-Col. Fox, chief of the Salvage Corps, objected to the use of heavy derricks, which he regarded as dangerous to the public, as well as overhead wires.

The Coroner then summed up, and submitted nine questions to the jury, whose verdict was to the following effect:—The fire was caused by a powerful electric current derived from the charged conductor rail of the District Railway, but whether due to accident or negligence was not shown. Telephone cables laid near high-pressure cables should be effectually protected. The contact of a telephone wire with a high-pressure conductor was not likely to be productive of danger of fire in subscribers' houses, or shock to operators or subscribers, when properly protected in both cases. The construction of the test room was unsatisfactory, and a greater use of non-combustible material and modern safety devices in all exchanges was desirable. Special powers were required to regulate all structural and other matters connected with the telephone service, but no Government inquiry into telephone risks and needs was necessary. Finally, the Oxford Court premises were not satisfactorily provided with means of escape from fire.

OUR PERSONAL COLUMN.

[*The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* Electrical Review *posted as to their movements.*]

Central Station Engineers.—The Carlisle T.C. has, by 18 votes to 15, adopted the recommendation of the Electricity Committee to increase the salary of Mr. Scurfield, deputy electrical engineer, from £150 to £175 per annum.

The Lighting Committee of the Brighton T.C. has recommended the appointment of Mr. Christie as engineer and manager of the electricity works in succession to Mr. Arthur Wright.

In consequence of the resignation of Mr. J. C. Elvy, his assistant, Mr. R. F. Windett, has been appointed superintendent of the meter department at Ilford. Previous to this he was on the staff of Westminster Electric Supply Co.'s meter department.

Tramway Officials.—In view of his retirement on the 30th inst., as engineer and general manager of the Brighton Corporation Tramways, to take up the position as general manager to the Hastings and District Tramways Co., Mr. T. B. Holliday was the recipient on the 23rd inst. of a handsome silver bowl. The presentation took place at the Tramways Depôt. Although naturally handicapped by heavy gradients existing on every route save one, the Brighton system has been singularly free from accidents. The presentation proceedings above referred to were marked by the utmost enthusiasm and unanimity.

Bailie Paton, of Glasgow, has been made the recipient of a number of public presentations in connection with his work in the Town Council. He is well known in the electric tramways world as the late permanent chairman of the Glasgow Tramways, a position he occupied since the Corporation took over the system along with Mr. John Young, now of London; he superintended the conversion of the cars from horse to electric traction, and at the last municipal election he lost his seat on the Town Council.

General.—The Electricity Sub-Committee of the Glasgow T.C. recommend that the salary of Mr. R. B. Maccall, chief clerk, who has been 31 years in the service of the Corporation, be increased from £275 per annum to £325, and the salary of Mr. W. T. Calderwood, chief draughtsman, who has been about nine years in the Corporation service, be increased by £50 to £300.

The Council of the City and Guilds of London Institute have conferred the Fellowship of the Institute on Mr. H. Cecil Booth, in recognition of the original and valuable engineering work which he has done since he gained his diploma of Associate of the City and Guilds Institute in 1892.

We are asked to state that Mr. H. M. Harris, director of Harris, Lee & Co., Ltd., of Johannesburg, will be in London at the beginning of next month, and can be seen by appointment at the offices of the company in 165, Queen Victoria Street. E.C.

Mr. J. F. Poynter has resigned his position as a traveller for the Supply Department, London, of the British Thomson-Houston Co. He has established the firm of Poynter and Sons at 52, Queen Victoria Street, E.C., as electrical factors and agents, and requires price lists and terms from manufacturers of motors, fans and arc lamps, &c.

Owing to increased business, the Reason Manufacturing Co., Ltd., have appointed Mr. F. Barnes Spencer, M.I.E.E. (late sales manager to Messrs. Ferranti, Ltd.) as contract manager. Mr. Spencer is shortly to visit the United States, and he will take up his new appointment about the beginning of June.

Mr. A. I. Graham, Assoc. M.Inst.C.E., A.M.I.E.E., engineer to Messrs. Thermit, Ltd., London, was married at St. James' Church, West Hampstead, on the 19th inst., to Audray Margheurita, eldest daughter of Mrs. Arthur Greig.

On April 26th at York, Mr. C. F. Mackness, of the Allgemeine Electrical Co.'s foreign department in London, was married to Miss Marion Raimes.

NEW COMPANIES REGISTERED.

Wandsworth Electrical Manufacturing Co., Ltd. (84,301).—This company was registered on April 17th, with a capital of £4,000 in £1 shares, to acquire the business of electrical manufacturers carried on by E. T. Davies, A. Reynolds, F. J. Ritchie, A. B. Smith, M. H. Galsworthy and S. S. Galsworthy, trading at 9, St. Paul's Square, Birmingham, as the Wandsworth Electrical Manufacturing Co., and to carry on the business of art metal workers, manufacturers of and dealers in all kinds of electrical fittings and accessories, electricians, engineers, suppliers of electricity for light, heat, motive power and other purposes, &c. The first subscribers (each with one share) are:—E. T. Davies, Yewdale, Western Road, Wylde, Birmingham, manufacturer; F. J. Ritchie, 67, Ivor Road, Sparkhill, Birmingham, manufacturer; A. B. Smith, 394, Monument Road, Birmingham, manufacturer; M. H. Galsworthy, 1, Cronfield Road, South Hampstead, N.W., electrical engineer; S. S. Galsworthy, 10, Craven Hill Gardens, Lancaster Gate, W., electrical engineer; A. Reynolds, Milford, Highbridge Road, Wylde Green, Birmingham, manufacturer; and H. Atkinson, The Cottage, Kingswood, near Knowle, clerk. No initial public issue. The number of directors is not to be less than three nor more than five; the first are E. T. Davies (chairman), A. Reynolds, F. J. Ritchie, M. H. Galsworthy and S. S. Galsworthy (life directors: special qualification, 490 shares). Qualification of other directors, £400 shares; remuneration as fixed by the company. Registered office, 9, St. Paul's Square, Birmingham.

National Electrical Manufacturers' Association (Incorporated) (84,318).—This company was registered on April 18th, with 500 members, each liable for not more than £1 in the event of winding up, to take over the property of the unincorporated association known as the National Electrical Manufacturers' Association, and to promote and protect the interests of electrical manufacturers and others dealing in or supplying electrical goods in the United Kingdom. The word "Limited" is omitted from the title by licence of the Board of Trade. The first subscribers are:—F. H. Nalder, 84, Queen Street, E.C., electrical engineer; H. Bevis, 67, Queen Victoria Street, E.C., electrical engineer; C. S. Northcote, 31, King Street, Covent Garden, W.C., electrical engineer; H. Oppenheimer, 55, Redcross Street, E.C., electrical engineer; O. H. Bishop, 96 and 97, Queen Street, E.C., electrical engineer; H. H. Berry, 78, Upper Thames Street, E.C., electrical engineer; and L. M. Waterhouse, Westinghouse Building, Strand, electrical engineer. The management is vested in a committee, the first members of which are H. Bevis, T. J. Grainger, A. P. Lundberg, F. H. Nalder, C. S. Northcote, H. Oppenheimer, S. Patersen and W. Smith. Registered office, 5, Ridler Place, Holland Street, Blackfriars, E.C.

British Type-Setting Machine Co., Ltd. (84,323).—This company was registered on April 19th, with a capital of £500 in £1 shares, to carry on the business of printers, mechanical and electrical engineers, machinists, fitters, typefounders, wire-drawers, &c. The first subscribers (each with one share) are:—W. B. Hardy, 64, Victoria Street, S.W., gentleman; P. J. Bircher, 64, Victoria Street, S.W., electrical engineer; E. M. Harwar, 5, York Buildings, Adelphi, W.C., journalist; P. Collins, 61, Kilmorie Road, Forest Hill, S.E., publisher; J. S. Rowlatt, 89, Highgate Road, N.W., clerk; E. A. Sanderson, 38, Fordel Road, Catford, accountant; and W. Webb, 22, Cathcart Hill, N., clerk. No initial public issue. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Arnold Goodwin & Son, Ltd., electricians, London (81,633).—A trust deed, dated February 8th, 1905, to secure £5,000 debentures, charged on the company's undertaking and property, present and future, including uncalled capital, was filed on March 27th by order of the Court. Trustee: H. W. Clarkson, Knutsford, Beckenham.

Scarborough Electric Supply Co., Ltd. (37,569).—This company's annual return was filed on March 25th, when the entire capital of £100,000, in 10,000 shares of £10 each, had been taken up. £10 per share has been called up on 9,000, and £2 per share on 1,000 shares, and £92,000 has been received. No mortgages or charges.

Hart Accumulator Co., Ltd. (60,059).—This company's annual return was filed on March 21st, when 40,000 ordinary and 4,315 preference shares had been taken up out of a nominal capital of £60,000 in £1 shares (20,000 preference). £1 per share has been called up on 17,500 ordinary and 4,315 preference, and £21,815 has been received. 32,500 ordinary shares are considered as fully paid. No mortgages or charges.

W. T. Henley's Telegraph Works Co., Ltd. (13,795).—This company's annual return was filed on March 25th, when the entire capital of £400,000 in 40,000 ordinary and 40,000 preference shares of £5 each had been taken up. £5 per share has been called up on 34,000 ordinary and 40,000 preference, and £370,000 has been received. £30,000 is considered as paid on 6,000 ordinary shares. Mortgages and charges: £44,800.

Wallace Lamp Syndicate, Ltd., London (80,790).—Particulars of a series of debentures to secure not more than £10,000, created by resolution of March 1st, 1905, charged on the company's undertaking and property, present and future, including uncalled capital, have been filed pursuant to section 14 (4) of the Companies' Act, 1900. No trustees.

Oldham, Ashton and Hyde Electric Tramway, Ltd. (55,318).—Issue on April 3rd of £7,000 debentures, part of series created June 20th, 1899, to secure not more than half the subscribed capital for the time being, charged on the company's undertaking and property, present and future, including uncalled capital. Trustees: Sir Chas. R. Wilson, G.C.M.G., C.B. 21 Pont Street, W.; and J. F. Frauheim, New Court, St. Swithin's Lane, E.C. Previously issued of same series, £40,000.

River Plate Electricity Co., Ltd. (75,569).—A memorandum of satisfaction, to the extent of £5,316, of a trust deed dated January 8th, 1903, securing £250,000, has been filed.

Scottish House-to-House Electricity Co., Ltd. (29,232).—A mortgage or charge on the company's undertaking and property, present and future, including uncalled capital, dated April 13th, 1905, to secure £2,500, has been registered. Holders: County of London Electric Supply Co., Ltd., Moorgate Court, E.C.

Yorkshire Electric Tramways Construction Syndicate, Ltd. (77,167).—A debenture, dated March 24th, 1905, to secure £50,000, has been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital (if any), subject to a debenture dated July 22nd, 1904, for securing £70,000. Holder: H. S. Leon, Bletchley Park, Bucks.

Tonyrefail and Gilfach Goch Electric Light Co., Ltd. (78,637).—Issue, on April 8th, of £835 debentures, part of series created December 6th, 1904, to secure £1,500, charged on the company's property, present and future, including uncalled capital. No trustees. No previous issue same series.

Auto-Electric Rifle and Target Co., Ltd. (76,336).—Issue, on March 31st, of £100 debentures, part of series created December 5th, 1904, to secure £5,000, charged on the company's property and undertaking, present and future. Holders: H. Pocock, 55, Cow Cross, E.C.; W. C. Brooks, 11—12, Clement's Lane, E.C. No trustees. Previously issued of same series: £2,700.

Kidderminster and District Electric Lighting and Traction Co., Ltd. (59,972).—A trust deed, dated April 5th, 1905, to secure £30,000 debenture stock (with power to issue further debenture stock, ranking *pari passu*, up to a total amount not exceeding the issued capital for the time being) has been registered. Property charged: The company's undertaking and property, present and future. Trustees: E. Garcke, Litton House, near Maidenhead; and C. S. B. Hilton, 41, Roland Gardens, Kensington.

Llanrwst Electricity Supply Co., Ltd. (62,720).—£4,400 debentures, created March 29th, and dated April 5th, 1905, charged on the company's property, present and future, including uncalled capital, have been registered. No trustees.

Electrical Trades Supply, Ltd. (67,616).—This company's annual return was filed on April 8th, when 4,507 shares had been taken up and paid for in full, out of a nominal capital of £5,000 in £1 shares. No mortgages or charges.

George Moritz, Ltd. (38,158).—This company's annual return was filed on February 25th, when 1,009 shares had been taken up out of a nominal capital of £5,000 in 5,000 shares of £1 each. £1 per share has been called up on 9, and £9 has been received. 1,000 shares are considered as fully paid. Mortgages and charges, £1,000.

Anglo-American Telegraph Co., Ltd. (2,981 C).—This company's annual return was filed on March 20th, when the entire capital of £7,000,000, in £698,600 consolidated ordinary stock, £3,150,700 preferred ordinary stock and £3,150,700 deferred ordinary stock, has been taken up and paid for in full. Mortages and charges, nil.

Liège Exhibition.—This exhibition was to be opened yesterday by Prince Albert of Belgium, but Press dispatches describe it as "in an absolutely chaotic state," and recommend intending English visitors to defer their visits until the end of May. The exhibition is to be a huge affair, with about 14,000 exhibitors. Something like 60 scientific congresses are to be held during the run of the show.

ELECTRICITY SUPPLY ACCOUNTS.

Hastings Municipal Electricity Supply.

We append this week the returns of the Hastings electrical undertaking for the year ending December last. These are of a very satisfactory nature, judging from previous years, and the surplus, especially, must be regarded as a promising omen.

Compared with the previous year, it will be seen that the department considerably increased its revenue at less expenditure than in that year, and, after meeting statutory charges, there remains a balance of £117 on the year's working compared with a deficit of £951 in 1903.

The prices charged are:—Private lighting, 6d. per unit, or fixed price of 10s. per 8-c.p. lamp per annum and 1½d. per unit; street lighting, £15 per kw. demanded, and 1½d. per unit per annum. The chief engineer is Mr. Russell F. Ferguson.

General Statement.

For year ending December 31st—	1904.	1903.
Total capital expended	£136,819	£131,832
Number of units sold—		
Private supply	678,619	623,662
Public lighting	228,976	228,432
Total number of units sold ...	907,595	852,094
Equivalent No. of 8-c.p. lamps connected	41,977	37,291
Number of public lamps	104 arc	104 arc
Maximum load in kw.	667	610
Revenue account—		
Gross revenue	£19,468	£17,977
„ expenditure	£9,871	£10,104
„ profit	£9,597	£7,873
Average price obtained per unit—		
Private supply	4·4d.	5·25d.
Public lighting	4·42d.	4·22d.

Revenue Account for Year ending December 31st, 1904.

Gross revenue	£19,468 = 5·15d. per unit.
Works and distribution costs (including public lighting)	£7,768 = 2·06d. „
Total working costs	£9,871 = 2·61d. „

Profit Statement, 1904.

Interest on loans	£4,420
Sinking fund	4,980
Bad debts	80
Balance on year's working	117
Gross profit	£9,597

CITY NOTES.

Meldrum Bros.

The report for 1904 states that after allowing for depreciation, and writing off large amounts expended in the development of the business, there is together with £2,630 brought forward from the previous year, a disposable balance of £9,573. The directors recommend a further dividend on the ordinary shares of 4 per cent., making 8 per cent. for the year, leaving to be carried forward £1,326. During the year the works have been kept fairly busy, although, owing to the depressed condition of the cotton trade in the first half of the year, the local orders for mechanical stokers and forced draught furnaces were considerably curtailed. Some very large and valuable contracts have, however, been entered into in these departments, and orders for several more important installations are pending, both at home and abroad. The current year opens with an excellent order book, and there is every indication that the works will be well occupied during the year. The directors, having in view the probable increased demands for the company's products, especially refuse destructors, a considerable number of contracts for which are now pending, have decided to offer a limited number of ordinary shares to the existing preference shareholders at a premium of 5s. per share, such premium to be placed to the reserve fund.

City of Birmingham Tramways Co.

The directors' report for 1904 recommends a dividend on the ordinary shares at the rate of 5 per cent. per annum for the six months ended December 31st, together with a bonus of 5 per cent. (making 10 per cent. for the year) and that £54,007 be carried to the reserve fund. The capital expenditure during the year amounted to £65,259, and comprised the purchase of new electric cars for the Ashton, Coventry Road and Pershore Road tramways, the construction of the overhead equipment of the Coventry Road tramways, and the purchase of the site and equipment of the generating station for the same. An arrangement had been made during the year, and it came into effect last July, with a view to the tramways of the Birmingham and Midland Tramways Co. being managed by a joint committee, in conjunction with the tramways and light railways of the Birmingham and Midland Tramways, Ltd., the Wolverhampton District Electric Tramways, the Dudley, Stourbridge and District Electric Traction Co., and the South Staffordshire Tramways (Lessee) Co. The joint committee was composed of all the directors of all the companies which are parties to the arrangement. An agreement had been concluded with the Corporation of Birmingham for the sale of the company's lines in the district of Balsall Heath. The company's lines and depôt in Aston Manor have been sold to that Corporation at £26,045. These lines will shortly be reconstructed for electric traction by the Corporation, and will be worked by the company in conjunction with other tramways of the Corporation within the district. The tramways formerly worked by the Birmingham and Aston Tramways Co., Ltd., had now been reconstructed for electric traction by the Corporation of Aston Manor. The directors were contemplating the substitution of motor-omnibuses for horse-drawn vehicles and for opening up new roads, and had placed contracts for the supply of motor-omnibuses for this purpose. Three such vehicles had already been delivered and put into service.

Bath Electric Tramways.

The report for 1904 states that during the year the construction of the system originally contemplated under the company's Light Railway Order was continued, and sections of the line were opened from time to time, until, on August 1st last, the final section was opened for traffic. A further order, acquired in the latter part of 1903, in connection with the extension over the Midland Railway, and known as the Midland Bridge route, is still in course of construction. In November, 1904, powers were sought from the Board of Trade for the construction of two additional lines, one of which, the extension to Newton-St.-Loe, about 1 mile 5 furlongs 9 chains in length, was authorised by the Light Railway Commissioners. The capital account of the company shows an expenditure to December 31st, 1904, of £302,545, which includes, under the advice of counsel, the cost of registration and formation, all management of the company prior to opening for traffic and the expenses of loans, &c., raised for capital purposes. The traffic receipts for the year 1904 amounted to £33,161, which must be regarded as satisfactory, especially as in the earlier part of the year the company was operating, under difficult conditions, only a portion of its system. After charging operating and administration expenses there remains a balance of £11,251, from which must be deducted interest accrued on the 4½ per cent. debenture stock £737, and dividend on the preference shares to December 31st, 1903, £2,844, leaving a balance of £7,670. The directors recommend a dividend at the rate of 5 per cent. per annum upon the preference shares to December 31st, 1904, leaving to be carried forward £3,920.

Sir Vincent Caillard (chairman) presided at Winchester House, E.C., on Wednesday over the meeting of the company.

In moving the adoption of the report, the Chairman said that last year the board expressed their intention to hold the annual meeting in Bath, but they found that the shares were still more largely used in London than in Bath, and consequently the convenience of the larger number of shareholders had to be considered. With regard to the balance-sheet, they would know that the balance of the preference shares had been issued since the accounts were made up on December 31st. They would notice £390, the balance and interest of loan account, but that was only a set-off against the Parliamentary deposit on the other side of the account. The sum of £878 for unclaimed dividends looked large, but the dividend was only paid two days before the end of the year, and therefore a considerable number of dividend warrants had not reached them at the time the accounts were made up. On the other side, the capital expenditure explained itself. The expenses of loan and debenture issue amounted to over £42,000, and were heavier than they could have wished; but they had to arrange for temporary financing in a most difficult year, in which it was almost impossible to borrow money at any price, and they naturally had to pay higher terms than they otherwise would. That temporary financing was now entirely got rid of, and the debenture issue had taken its place. There was nothing special to speak upon in the revenue account, although they hoped in a normal year the general expenses and law charges may be somewhat reduced. The traffic receipts he hoped they would regard as really satisfactory seeing that they did not represent the entire work of the whole year. Their original scheme was for 13 route miles, and they commenced on January 1st last year with only 10 cars operating over six miles of route, and they gradually increased their mileage and number of cars until on August 1st the complete system came into operation. Their daily average of cars was 28, and their total car-mileage amounted to 900,250 car-miles. They carried 6,648,133 passengers, which meant that they carried the entire population of Bath nearly 86 times over. These figures showed that their system was a good and live one. Their power cost, including coal, water, wages, oil, upkeep of machinery, and a proper proportion of rates and taxes worked out at ·865d. per car-mile. The operating costs, which covered all the expenses of running of the cars except power, amounted to 4·043d. per car-mile. To put the figures in another way, he might tell them that their total operating costs were 59·65 per cent. of their gross revenue. Those operating costs they were confident would be reduced next year under their excellent managing director. This figure, of course, depended more on local management than on the board of directors, and he was assured by the general manager that the working expenses would be considerably reduced. Considering this was the first year of their operations, he thought they had good reason for looking on the past with satisfaction, and if they compared their accounts with other companies more pretentious they would come out very favourably. As to the future, he would call their attention to the construction of the Midland Bridge route, which they hoped would be

open within a reasonable time. The tramway would go by a bridge over the Avon to the Midland Railway station, and when it was opened it would increase their receipts, and very slightly increase the operating expenses. Last autumn they made two applications for extensions, and that to Newton-St.-Loe was authorised. That route should be very valuable to them, especially in the summer. The application for the Westgate Street route met with opposition, but they did not think it impossible that this opposition would be withdrawn; they were going to adopt a system of motor-omnibuses in order to feed the tramways and to penetrate much further into the country in search of traffic than they could do by tramways. With these motor-'buses they would be able to serve Lansdown Hill, which was too steep for tramways.

Mr. H. F. Clutterbuch seconded the motion.

Mr. Pope and Mr. Hunter criticised the figures in the balance-sheet, and the latter shareholder warned the directors of the danger of going into schemes which Bath could not support.

Col. Weston asked when there was a likelihood of getting a dividend?

The Chairman said they already carried forward a sufficient sum to pay a dividend, and he did not see what was to prevent a dividend being paid next year.

The report was adopted.

Kalgoorlie Electric Power and Lighting Co.

The directors report that during the year 1904 the plant worked very satisfactorily. Contracts for power have been made with several of the largest gold-mining companies, the full benefit from which will not be derived, however, for a few months, pending completion of the erection of the machinery ordered by them. Considering the amount of power to be taken under these contracts, and the extensions to the northern end of the field which are in progress, the load factor will be much improved. The profit on working for the year 1904—viz., £18,334—was nearly 100 per cent. above that of the previous year. The directors have dealt with the balance of this account, after paying debenture interest and London expenses, as follows:—To reserve for depreciation, £6,750; writing off the balance of preliminary expenses, £5,486; writing off the cost of issuing debentures, £344; making provision for the premium payable on redemption of debentures, £660; and carrying forward £812. Comparing the balance-sheet with that of 1903, the whole of the bank overdraft and bills of acceptance, amounting to £13,650, have been paid off, and at December 31st, 1904, there was a cash balance of £4,713. The directors, although the plant is efficiently maintained out of revenue, have deemed it advisable to establish a reserve against depreciation, which, with the contingency fund of £1,000, gives a total on reserve accounts of £7,750.

River Plate Electricity Co.

The report for 1904 states that the net revenue for the year, after providing debentare interest, writing off depreciations and the balance of preliminary expenses, amounts to £10,436. To this must be added £2,829 carried over from last year, making an available balance of £13,265. The directors recommend the payment of the year's dividend upon the 6 per cent. preference shares, that £4,000 be placed to a contingency fund, and that the balance of £3,265 be carried forward. The accounts might have permitted a distribution on the ordinary shares, but the board are of the opinion that, pending the reconstruction of the company's stations now in progress, it is in the best interests of the shareholders that they should carefully husband their resources. During the year the transfer of the Buenos Ayres property to the German Trans-Oceanic Electric Co., of Berlin, has been formally completed. The agreement between the company and the Government of the Province of Buenos Ayres for the acquisition by the company of the Government's interest in the La Plata station and for the extension of the public lighting contract, having been approved by the Chamber of Deputies and the Senate, has been executed by the Governor of the Province. The board have sanctioned the erection of a new and enlarged station upon the site acquired. It is hoped that the new station will be in operation and the transfer from the existing station substantially complete within 15 months. Important improvements and extensions have also been authorised at Tucuman, the works in connection with which have already made some progress.

Calcutta Electric Supply Corporation.

The report for 1904 states that the number of units of electrical energy sold during the year was 2,760,457,an increase of 35 per cent. Gross revenue from all sources amounted to £60,243, an increase of 27¾ per cent. Working costs, including provision for renewals, were £30,744, an increase of 20 per cent., and the net revenue £29,499, an increase of 36½ per cent. Capital expenditure during the year has amounted to £41,733, the principal items of which are freehold land and buildings £3,995, machinery and tools £15,996, mains £14,163, meters £6,615, and £665 on electrical instruments. The total capital expenditure at December 31st last amounted to £424,503. The directors, in view of the capital outlay, have increased the amount set aside for renewals fund account to £11,000 (which is £2,500 over the amount set aside in the preceding year.) Of the sum so provided £4,093 has been expended in repairs and renewals, and £370 has been written off, leaving a balance of £21,815 carried forward as a reserve for renewals. During the year the directors have made a further issue of 20,000 shares of £5 each at a premium of £1 per share. The premium, less the cost of issue, have been added to the reserve fund, which now stands at £54,592. The available balance of net profit, after deducting the interim dividend paid in November, 1904, interest on loans, income-tax, is £21,279. The directors recommend a final dividend at the rate of 10 per cent. per annum for the half-year on the paid-up share capital, making, with the interim dividend, 8 per cent. for the year, and that the balance of £4,720 be carried forward. A general Electricity Act for India was passed in 1903, and it is now proposed that this company's licences on the Calcutta side of the Hooghly shall be combined in one licence under the new Act. A print of the new licence has been received from the Government. The new licence will vary to some extent the terms under which the company holds its undertaking; but the directors, after careful consideration, have come to the conclusion that in the interests of the company it is desirable that it should be accepted, and accordingly a resolution will be proposed approving the same.

Rand Central Electric Works.

The report for 1904, to be presented at the meeting on the 27th inst., states that the power supplied during the year has yielded a revenue which exceeds that of the preceding year by £24,305, and, as a result, the working profit, before deducting the sum allocated to depreciation, amounts to £48,450, as compared with £28,540 for 1903. The receipts derived from the supply of power and rent of plant aggregated £94,818 against £70,513 for the year 1903. Interest on deposits and profit on exchange, &c., have further increased the revenue by £1,361, bringing up the gross receipts for the year to the sum of £96,179. The accounts show a gross profit of £48,451, and after making provision for £16,670 set aside for depreciation, there remains a balance of £31,780, from which has to be deducted the balance standing to debit of profit and loss account at the end of 1903 of £11,947, and £307, balance of royalty due to the Transvaal Government under the concession, leaving a net balance of £19,525, out of which the directors recommend a dividend of 5 per cent. per annum, carrying forward £4,525. The general manager's report shows that the total power generated during the year was 10,266,410 kw.-hours as compared with 8,192,680 kw.-hours for the previous year, or an increase of 2,073,730 kw.-hours, equivalent to an increase of about 25 per cent. The demand for the year was of a steady and uniform character. The extension of the plant by a steam turbine of a capacity of 400-kw. is now in progress, and the erection of the machinery is nearing completion. The vacancy on the local board occasioned by the death of Mr. R. S. Strakosch has been filled by the appointment of Mr. Max Francke, who, during the temporary absence of Mr. Brakhan, officiated as chairman of the local board, and is possessed of an intimate acquaintance with the company's affairs. A further vacancy has recently occurred through the resignation of Mr. George Hesse, who has been a member of the local board for some years.

Eastern Extension, &c., Telegraph Co.

The report for the half-year ended December 31st, 1904, states that the gross receipts have amounted to £331,788, against £265,259 for the corresponding half-year of 1903. Working expenses, including £35,471 for maintenance of cables, absorb £150,035, against £142,419 for the corresponding period of 1903, leaving a balance of £181,753. After paying income-tax and interest on mortgage debenture stock, there is a net profit for the half-year of £166,911. After adding £110,270 brought forward from the previous half-year there is an available balance of £277,181. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1904. The sum of £120,000 has been transferred to the general reserve fund, leaving £22,181 to be carried forward. Since the close of the financial year the capital account has been increased by a further issue of £150,000 of 4 per cent. mortgage debenture stock, thus making the total issue to date £752,400. The meeting of the Pacific Cable Conference, which has been deferred from time to time, is now proposed to be held next month.

Barcelona Tramways Co.

Mr. J. B. Concanon presided at the meeting held on 17th inst., and in moving the adoption of the report, he said that the receipts for the year had increased by £15,400. They had carried 5,111,306, or 14½ per cent., more passengers; and they ran 83,833, or 2½ per cent. more miles, and the expenses showed an increase of £1,336. There would had been a decrease of nearly £1,300 in taxes, and this year they probably have a saving of a further £1,000. This was due chiefly to the Spanish Government having almost entirely wiped off the very heavy tax they had on currants. The Ensanche line, for the first time since this company had electrified it, had not only paid the full interest on the large loan, but had a surplus on working of nearly £800, which went to the reduction of the loan. In regard to the coming year, if the traffic did not decrease and exchange remained about the same, the company ought to be about £6,000 or £7,000 better off. They would be relaying a considerable portion of the line this year at a cost of £5,000. Negotiations were proceeding with the municipality for the unification of the company's concessions.

British Aluminium Co.

The meeting of this company was held on 18th inst. at Winchester House, Mr. J. D. Bonner presiding.

The Chairman, in proposing the adoption of the report, said that upon each occasion that he had been in the chair, he had been privileged to move the adoption of a report showing better results than its predecessor, and this time a surplus available for distribution was disclosed sufficiently large to enable the dividends to be paid on all classes of their shares. That progressive improvement might be attributed principally to increased sales, though no small part of it was due to the considerable reductions which had been effected during the period in the cost of production. In 1901 their profit was £12,524, in 1902 it rose to £20,770, in 1903 it further rose to £34,143, and last year it exceeded £55,400. He did not think he was over rash in predicting that their profit this year would be far in excess of that in 1904. During the last few years they had had to realise gradually the large stock of aluminium accumulated years ago, and the conversion of that stock into cash had not, owing to the price at which it stood in their books, enhanced their profits to any appreciable extent. If they had produced during last year all the aluminium that they sold, their profits would have been much larger. This year their production at Foyers would be materially greater, but, owing to the reason he had indicated, only a moderate increase in their sales was necessary to ensure the disposal of the whole of it. Upon that increase he confidently counted, and he was pleased to be able to inform them that their sales during the first three months of this year had been much in excess of those in any previous quarter. The continuous expansion not only in the demand for aluminium, but also in the number of directions in which it was found that the metal could be advantageously employed, was very gratifying and important to them, and emphasised the necessity of hastening as much as possible the completion of the Loch Leven Power Works. Under the Acts of Parliament authorising them, those works must be carried out by the Loch Leven Water and Electric Power Co. The shares in that company, which would have to be issued to cover the cost, would all be subscribed by this company, so that they would own the entire undertaking. He hoped next month that the Loch Leven Co. would be in a position to invite tenders for carrying out the works, so that the contract might be settled, and a start made this summer. The expenditure to be incurred was large, but there was every indication that it would prove highly remunerative, for it was expected that more than twice as much power would be obtained at Loch Leven as they had at Foyers. When that power was at their disposal—say, in a couple of years' time—they would not necessarily be so dependent upon the continued prosperity of a single industry as they were to-day. If then they found they did not want to utilise the whole of the power themselves, there was a good prospect of their being able to let a considerable part of it upon advantageous terms for electro-chemical or other purposes. Meanwhile, unless there should be an alteration of an adverse character in existing trade conditions, which he did not anticipate, they would be in a splendid position. Now that the extension of their Foyers water power was completed, and their works there were fully employed, they hoped to be able, even before the Loch Leven Works became productive, to earn profits sufficient to enable the dividends to be maintained on all their shares, including those shortly to be issued. Speaking with a full sense of responsibility as their chairman, he might say that he should not countenance the payment of the 7 per cent. dividend upon the ordinary shares now if he did not see a reasonable prospect of maintaining it upon the enlarged capital. The fact was, this company was now in a thoroughly sound condition. It had a large and increasing business, which they would do their utmost to extend, and there was every indication that it would have a prosperous future.

Mr. H. Wolfenden, the vice-chairman, seconded the resolution, and the report was adopted.

Subsequently, Mr. James proposed a special resolution placing £5,000 at the disposal of the chairman and the vice-chairman, in recognition of their services to the company in placing it on its present satisfactory basis. After some discussion, in which the opinion was expressed that the present was too early a stage to vote such a large sum, an amendment was carried reducing the amount to 1,000 guineas each.

Indo-European Telegraph Co.

Mr. J. H. Tritton presided on Tuesday at the offices, 18, Old Broad Street, over the meeting of this company. In moving the adoption of the report, he said they all deeply regretted the retirement from the board of Mr. W. S. Andrews, owing to failing health. He occupied for many years, not only in their company, but in the telegraphic world at large, a very eminent position, and the reference to him in the report by no means overstated his colleagues' appreciation of his services, and the company's indebtedness to him. In his place, the directors had elected Sir Francis Mowatt, till lately a distinguished servant of the State, whom they welcomed at that meeting. Agreements had been concluded by the company with the Postmaster-General and the Director-General of German Telegraphs for the leasing of wires in two cables between this country and Germany, and land wires between London and Lowestoft, Manchester and Liverpool. They therefore started the year 1905 with all their concessions and agreements finally extended. Last year the shareholders were informed that reductions in the rates had been made—reductions recommended and carried at the International Telegraph Conference held in the summer of 1903. Some of these reductions had adversely affected the company's receipts, but, fortunately, the improved trade with India had brought about a considerable increase in the Indian traffic, and this had, to a great extent, lessened this effect. The reduction in South Russian rates had caused a diminution of receipts, though here also the traffic had shown a satisfactory increase. Large reductions had been made in the tariffs for messages exchanged with the Far East—China, Japan, and the Philippines, &c.—which would have materially affected their revenue from this source but for an increase of traffic, largely due, in his opinion, to telegraphic activity in connection with the troubles in the Far East. The prospects of receipts for the next financial year were perhaps not as satisfactory as they could wish, although he did not think it was necessary to take a pessimistic view. He was glad to say that the working of the line during the past year had been eminently satisfactory. While upon this subject, he should like to give them the benefit of a few statistics that had been placed in his hands by the managing director. Messages were carried, without any intermediate re-transmission whatever, from one end to the other of their line to Teheran, a distance of about 4,000 miles. The speed of working was between 30 and 40 words per minute, though there were 11 automatic relay transmissions before Teheran was reached. The number of words transmitted showed since 1899 nearly 50 per cent. increase; the number of errors made, a decrease of nearly 70 per cent.; and the average time of transit over their line, a decrease of, say, 33 per cent. The number of staff had, after some fluctuation, returned to the same figure as in 1899. They were now in a position to cope with much heavier traffics, and this was a most satisfactory state of things. The credit for this marked improvement must be duly apportioned. The complete Wheatstone installation was due to the initiative skill and persevering energy of the managing director, Mr. T. W. Stratford-Andrews, well seconded by the staff, technical, maintenance and operative. As an encouragement, and in appreciation of these facts, the directors voted the sum of £4,200 by way of bonus, to be divided amongst all the members of the staff. The last occasion on which a bonus was distributed was in the year 1894, just 11 years ago. The board felt sure that this would meet with the shareholders' approval. The company had had a good year, and they thought it only fair to show the staff that the company was not unmindful of the willingness and energy displayed by all the members on the shareholders' behalf. The revenue showed a small increase, as also did the expenses, but this latter was caused by the bonus which had been paid to the staff. The maintenance charges also included a proportion of this bonus, the actual expenditure on the maintenance of the line being £22,900, a decrease of £3,500 as compared with last year. These charges were more or less uncertain, and this decrease might not be permanent. The proposed dividend (£14,875) and bonus (£17,000) absorbed together £31,875. The directors proposed to add £15,000 to the equalisation of dividends fund, which would then amount to £46,292, and to hand over a further sum of £5,000 to the trustees of the retirement trust fund, carrying forward about £19,300. The interest on the reserve fund investments had hitherto always been credited to the reserve fund year by year. The directors were of opinion that, the reserve fund investments having now reached a figure equivalent to the capital of the company, this interest might be dealt with at their discretion, and they had decided, therefore, on this occasion to recommend a special distribution to the shareholders from this source. The shareholders were informed at the last general meeting that the Russian section of the line would pass to the Russian Government at the end of 1904. This section had become the property of the Russian Government under the company's concession since January 31st, 1905, and would be formally handed over to representatives of that Government as soon as the necessary formalities were completed. As some misapprehension seemed to have arisen last year in this connection, he thought it well to mention to the shareholders that under the concession, which would continue until January 31st, 1925, the company had the sole use of the same lines as hitherto, though they were now leased to them for the term of the concession, instead of being their actual property, the maintenance remaining in their hands as before. The transfer of this section of the line from a financial point of view would be dealt with in the accounts for 1905, and would involve the writing off of the cost of the Russian section of the line, which stood in the balance-sheet at £313,285 5s. 5d., against the reserve fund on the other side of £446,045 17s., leaving over £130,000 on this account. They were thus entering upon the prolonged concessionary period, with their capital absolutely intact, and a list of investments which could stand the most rigorous criticism.

Sir W. R. Brooke seconded the adoption of the report, which was agreed to without discussion.

The retiring directors and auditors were re-elected, and the meeting closed with a vote of thanks to the staff.

Kalgoorlie Electric Tramways, Ltd.

The meeting of this company was held on 18th inst. at Winchester House, Mr. Allen H. O. Stoneham presiding.

The Chairman, in proposing the adoption of the report, said it was his pleasant duty to congratulate the shareholders on the results of the past year's working. The accounts showed a very satisfactory profit, notwithstanding all the disadvantages of a partly developed traffic over a large part of their system. He was told that the profits made by their company were larger than those made by the L.C.C. South London tramways, but then, the Kalgoorlie tramways were run for profit, while in London, he was told, the tram

ways were run for votes. Satisfactory as their profits were, they could make much more in the future. They were now paying an exorbitant price for power, having at present to purchase it from the Kalgoorlie Electric Power Co. at 4d. per unit, whereas they were advised they could get power for 2d. per unit. They were now paying the Power Co. over £16,000 a year, and obviously, therefore, if they could get the price of power reduced to 2d. per unit, they would save £8,000 in expenses, and increase their profits by that sum. 4d. per unit was a very reasonable rate to pay when they entered into the contract with the Power Co., because at that time water was very expensive, and the Power Co., not believing that the Government water scheme would be successfully carried through, went to enormous expense in erecting air condensers. Fortunately for Kalgoorlie, although unfortunately for the Power Co., the Government water scheme had been successful, and the vast expenditure on condensers had proved to be totally unnecessary; so they could quite understand that by putting up their own plant they could get power a great deal cheaper than the Power Co. could afford to supply them, and at the same time get dividends for their shareholders. Their negotiations with the Power Co. had, he was sorry to say, been unsuccessful, and they did not see any other course open except to erect their own power house. The directors of the Power Co. would not, he was sure, lightly throw away a certain income of £16,000 per annum, which must be a very considerable proportion of their total receipts, but owing to the fact that they had to spend so much money on their condensers and to put up their power house at a time when machinery and labour was so expensive, they were unable to meet them to the extent they desired, and also to make a profit on their capital. Under those circumstances, all they could do was to erect their own power house, but the shareholders need not be alarmed, as he did not anticipate that they would want to trouble them for any capital. That would be provided by manufacturers and others who would take payment over a period of years out of profits. They had no doubt as to the future of the company. The population was increasing, and the miners were buying land on the tramway routes and were building houses to which they were bringing their wives and families. Kalgoorlie would always be the centre for the surrounding districts, and he thought he might safely prophecy that directly they got their power house they would be able to increase their profits by £10,000 per annum.

Mr. C. C. Baker seconded the motion, and the report was adopted.

Auckland Electric Tramways Co.

During 1904, £85,100 debenture stock was disposed of, and the issued share and debenture capital now amounts to £585,100. The total capital expenditure during the year amounted to £63,951. The traffic receipts amounted to £110,574, as compared with £81,773 for the previous year, and the total revenue to £112,429. After deducting all expenses chargeable to revenue, including £12,235 for debenture and other interest; £2,521 for rental and percentage of profits payable to the Auckland City Council; and £4,658 balance of expenditure in connection with the Kingland accident, there remains a profit of £26,276 which, added to the amount of £2,323 brought forward from the previous account, makes £28,598 available for distribution. It is proposed to reserve to meet depreciation, £7,500; to pay a 6 per cent. dividend, £18,000; and to carry forward £3,098—£28,598. The depreciation and reserve fund will then stand at £18,050.

The system has been extended by the completion of a further 1·44 route miles, which were opened for traffic on August 24th, making the total length at present under operation 18·64 miles. It is intended to immediately construct a further extension of 0·57 mile, which will complete the system as at present determined upon. The company has been approached by various local authorities in the vicinity of Auckland with a view to the extension of the company's system into their districts, and these proposals are receiving the careful consideration of the board. The serious accident which occurred on December 24th, 1903, involved the company in an expenditure of £8,658 in excess of the amount covered by insurance. To meet this, £4,000 has been provided by the utilisation of the amount set aside out of the revenue in 1903 for contingency provision account, the balance being debited to the profit and loss account for 1904. To meet increasing traffics the rolling stock has been increased to 55 cars by the purchase of 12 additional passenger cars; only four of these were available up to the end of the year. An additional 600-kw. set has been installed in the company's generating station, which is now capable of an output of 1,525 kw.

Miles open—	Year ended Dec. 31st, 1903.	Year ended Dec. 31st, 1904.
Route miles	17·2	18·64
Single line..	5·4	6·44
Double line	11·8	12·20
Number of passengers carried	18,535,611	18,045,703
Average receipts per passenger	1·42d.	1·47d.
Average expenditure per passenger ..	0·83d.	0·89d.
Proportion of expenses to receipts ..	58 per cent.	60 per cent.
Number of cars working	43	47

Cuba Submarine Telegraph Co.

Mr. C. W. Parrish presided at the half-yearly meeting held at 58, Old Broad Street, E.C., on April 19th. In moving the adoption of the report (see Electrical Review, April 14th), he said that it dealt with an unfortunate half-year during which they were carrying on the business under considerable difficulties. At the last meeting he explained that the Cape Cruz-Santiago section had been interrupted on June 14th when the great storm fell upon that part of the coast of Cuba, and that the new cable to Santiago would not be laid until December or January. Their working cables were therefore very limited, and their traffic had to be carried on under somewhat unusual difficulties. The resources of the company had, however, enabled them to meet those difficulties. No expense was spared and longer hours had to be worked at stations, with a result more satisfactory than might have been expected. Cable companies were naturally subject to these partial breakdowns, and when they occurred they fully appreciated the advantages of having as far as possible duplicate cables and a good reserve fund. Since the end of the year the new main cable Cienfuegos-Santiago had been laid, and the Cape Cruz-Santiago section had been repaired, so that they had now returned to their normal position. The new cable was working very well, and although it was impossible to prophesy as to what might take place at the bottom of the sea, he believed they had done all that was necessary to ensure the rapid and safe conveyance of their traffic. As compared to the last half of 1903, the receipts from traffic showed a considerable falling off, viz., £16,205 in 1903, £11,945 in 1904; but the 1903 receipts profited considerably from their having had the temporary advantage of some of the French company's traffic owing to their New York-Hayti cable being broken, so that the difference was not due to any great falling off in the normal traffic. The receipts from investments had been reduced owing to the calls they had had to make on the reserve fund, but altogether they had received a gross income of £13,814, and had a balance of £4,647 brought forward, making £18,461, which, after meeting working expenses, enabled them to pay the 10 per cent. preference dividend and 5 per cent. on the ordinary, carrying forward £3,093. The payments on account of the new cable and the cost of the attempted repairs to the Cape Cruz cable had been charged direct to the reserve fund, and they had also transferred from that account some £8,174 spent upon repairing cables during the Spanish-American War, and had placed the amount to suspense account. They had further payments on account of the new cable and repairs to come into the present half-year, amounting to some £18,000, which would also be charged in due course to the reserve fund. The current expenses of the half-year under review were unusually high, on account of the special conditions under which they were working, but they would now return to their ordinary level. Unfortunately the company's claim against the American Government had made no progress, and he was very sorry to have to say that the President of the Island of Cuba had decided against their claim for the subsidy due to them for the coast cables. This was a most unexpected disappointment, as they believed that their claim was perfectly just and clear; they must now appeal to the Law Courts and hope that the decision of the President would be reversed. The prosperity of the Island was great at present. A bountiful sugar crop was being gathered, and in many directions new industries and developments were being initiated. All of this should add to their traffic, and he hoped that they would have to give a satisfactory record of a busy current half-year.

Mr. George Keith seconded the motion, and after a word or two from shareholders, it was carried unanimously.

Oriental Telephone and Electric Co.

The directors' report for 1904 says that including £1,737 brought forward at December 31st, 1903, and after deducting the interim dividends of 3 per cent. paid November 1st on both the preference and ordinary shares and other charges, the amount to be dealt with is £12,422. It is recommended that a dividend be paid to December 31st of 3 per cent. on the preference shares = £1,425; a final dividend of 3½ per cent. on the ordinary shares making 6½ per cent. for the year = £6,276; and that there be placed to reserve, £3,000; leaving a balance of £1,721 to be carried forward.

The Telephone Co. of Egypt has been enabled to declare dividends of 7½ per cent. for the past year, less income-tax, on both its preferred and deferred shares, which have been included in the accounts. That company has received a further contract from the Government of H.H. the Khedive for the installation of an additional batch of provincial telephone lines. In order to provide capital for these lines and for other extensions of its business, the Telephone Co. of Egypt made an issue in July last of £60,000 of 4½ per cent. debenture stock, part of an authorised issue of £200,000. The 5 per cent. mortgage debentures originally issued, amounting to £10 500, of which this company held £9,000, were paid off. The new stock is now officially quoted. The exchanges worked by the company generally show improving revenues. At Singapore, land has been purchased for new exchange premises which are now in course of erection. The company's engineer has returned to that port after having visited the stations of the company in the East and personally superintended in London, the ordering of material in connection with the underground cabling requirements. At Maulmain a suitable building has also been purchased for exchange and residential premises. The Indian local companies have paid the same dividends as for 1903. The Bombay Telephone Co.'s new premises will be completed very shortly. The work of underground cabling its system in the City of Bombay has already commenced.

The Government of India having compulsorily acquired the premises in the occupation of the Bengal Telephone Co. in Calcutta, the removal of that company's central exchange has become necessary. The Government has granted compensation for this compulsory removal. New and improved switchboards have been ordered and it is hoped these will be installed during the autumn, by which time it is expected underground cabling operations will also be in progress. It will thus be seen that in the three cities of Singapore, Bombay and Calcutta the work of underground cabling required by the new licences has been taken in hand. In Rangoon, Maulmain and Madras, the work will be commenced within the next 12 months.

The China and Japan Telephone and Electric Co. has received a licence from the Hong Kong Government for a term of 25 years. The system there will now be thoroughly overhauled and reconstructed with underground and overhead cables. The business at Hong Kong is progressing very favourably. The electrical business of the company has not been so satisfactory as in the previous year, but orders have been secured for completion during the current year, which will, it is expected, show a more favourable result.

Wycombe (Borough) Electric Light and Power Co.

The annual report for 1904 says that considerable progress has been made by the company during the year, the connections having risen from 31,930 to 37,383, being an increase of 5,453 (8-c.p.) lamps. Including a balance of £93 brought forward from the previous year, there is a profit to the credit of the net revenue account of £3,855, and, after paying interest on debenture and loans amounting to £2,122 (including £100 written off for bad debts), there is a surplus of £1,826.

The directors recommend the payment of a dividend at the rate of 4 per cent. for the year, which will absorb £1,200, and that £500 be placed to the reserve fund for renewal of plant, leaving a balance of £126 to be carried forward to next year's accounts. Edmundson's Electricity Corporation, Ltd., have again waived their claim for a portion of the interest due on overdue accounts.

British Columbia Electric Railway Co.—The shareholders, at a meeting held on 19th inst. approved an agreement providing for the electrification and operation by this company of the railway line from the City of Vancouver to Steveston, Lulu Island, and for increasing the capital to £1,000,000 by the creation of 150,000 new shares of £1 each. Mr. R. M. Horne-Payne, who presided, said that the Vancouver power tunnel would be finished within a week. The completion of the tunnel marked the successful termination of one of the finest electric installations ever contemplated—unique in its great tunnel through 2½ miles of granite mountains several thousand feet high, unique in its splendid natural balancing reservoir, and unique in that the power was conducted high overhead over navigable waters. It also marked the moment when the power would be turned on, once and for all, to carry the whole of the company's load in the mainlands of British Columbia. The immediate results of the water-power would be seen, he thought, from now on in the monthly traffics. One of the results was the contract the board had made with the Canadian Pacific Railway for a sale of power. The contract, if it worked out successfully, would, no doubt, be brought into force over other parts of the Canadian Pacific system.

Stock Exchange Notices.—The Committee have ordered the undermentioned securities to be quoted in the Official List:—British Electric Traction Co., Ltd., further issue of 5,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 356,438 to 361,437.

Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to—Shawinigan Water and Power Co.—scrip (fully and partly paid) for $2,000,000 5 per cent. consolidated first mortgage bonds. And to allow the following securities to be quoted in the Official List:—Electric Lighting and Traction Co. of Australia Ltd.—further issue of £70,000 5 per cent. first debenture stock; Primitiva Gas and Electric Lighting Co. of Buenos Ayres, Ltd.—further issue of £94,900 4 per cent. first debentures of £100 each.

Brush Electrical Engineering Co.—The directors recommend payment of the full 6 per cent. dividend on the preference shares for the year ended December 31st, 1904, placing £7,000 to general reserve, £6,500 to depreciation reserve, and carrying forward £3,080.

St. James' and Pall Mall Electric Light Co.—The amount of electricity sold for the quarter ended Lady Day is returned at 2,332,361 units, estimated to produce £34,985, as against 2,330,724 units, which produced £36,320 for the corresponding period of last year.

South London Electric Supply Corporation.—The company reports having sold, during the quarter ended Lady Day, 2,457,880 units, realising £20,640. The figures for the corresponding quarter in 1904 were 2,120,539 units, realising £18,600.

Traction and Power Securities Co.—Mr. W. I. Buchanan presided at the annual meeting held last week, and, among other things, said that the company had increased its investments during the past year by £42,399 by its holding in the Clyde Valley Power Co. The company's total investment in that concern was now £120,439. Two power stations of the Clyde Co. were now nearly completed; the first was expected to be in operation in May, and the second in September. A large demand for power at remunerative rates might be anticipated at once. This company will take over the remaining £249,276 of Mersey Railway debentures shortly, thus increasing its holding in that railway to £620,000.

Prospectus.—The Indian Electric Supply & Traction Co. was before the public on April 19th and 20th, with an issue of £25,000 of 6 per cent. construction debenture stock. The registration of the company was announced in our last issue. Messrs. Kincaid, Waller & Manville, are the company's consulting engineers in London, and Messrs. Kilburn & Co., of Calcutta, are the general agents and supervising engineers in India. The company is first to construct an electric tramway in Cawnpore, and to supply lighting and power there. Messrs. Crompton & Co., Ltd., being the contractors.

Cape Electric Tramways, Ltd.—The meeting of this company, which was held on 19th inst., resolved, by 291,327 votes to 54,711, that Mr. Alfred Parrish be removed from the board. Mr. Parrish had attacked his colleagues in a circular regarding the position of the other directors and Messrs. Wernher Beit & Co. in connection with the proposed leasing or purchase of the Camps Bay tramways. He contended at the meeting that turning him off the board would not affect the main point that was in dispute.

Oswestry Electric Lighting Co.—The annual meeting was held on 25th inst., Mr. Wynne Corrie presiding. The receipts continue to increase satisfactorily, and the available balance of profit amounted to £538. After adding £163 to the reserve fund, it was decided to declare a dividend of 4½ per cent.

STOCKS AND SHARES.

Wednesday Evening.

Interruptions to Stock Exchange business are still abundant. Political uncertainty, holiday influences, progress of a fortnightly settlement, and general hesitation on the part of the public—these restrict investment orders very considerably, and the only active speculative department is the American Railroad, the animation in which provides rather a doubtful benefit to markets at large.

Eastertide did little to help the electrical railway companies, the Central London publishing a decrease of £322, while the City and South London had a decrease of £253. For the half-year to date the figures are £2,003 increase and £2,734 decrease respectively. City and South London shed another ½ to 43½, and the market for the stock seems to be almost backboneless. Metropolitan Consolidated weakened to 96½, and Distr.cts went flat to 38½, a fall of two points. This dulness, on the eve of electrical working, does not augur well for the immediate future of the stock. Great Northern, Piccadilly and Brompton Ordinary are 9, and the Preferred about ¼ premium. Great Northern and City Preferred changed hands the other day at 5⅞, but this was in an odd parcel of shares: a number more negotiable could have been bought at a lower price. East London stock attracted some slight attention at 5½. Baker Street and Waterloo Debenture has again hardened to 4½ premium, there being little stock on offer to supply a fairly healthy demand.

While Traction issues are well supported, it cannot be said that business in them is at all brisk. Cape Electrics at 1⅞ are ¼ easier after the meeting. There have been a few sellers this week of Buenos Ayres Grand National First Preference, and whereas it was difficult to buy the shares at 7 a month ago, to-day it is equally difficult to sell them at 6. The postponement of the scheme has prompted certain holders to realise, and the market is not sufficiently free to tempt dealers to put the shares on their books. Other Argentine traction descriptions remain unchanged. Anglo-Argentine Ordinary at 8½, Belgrano at 3⅝, and City and Buenos Ayres Tramway (1904) shares at 5⅞ show no alteration, but Anglo-Argentine Preference improved ⅛ to 6. London United Preference are 10½, and despite the chilly weather, the trams did good business through the holidays. Metropolitan Electric Debenture stock is good at 106, rather buyers, and Perth (West Australia) Electric Trams 5 per cent. Debenture is the same price. Calcutta Trams were sold as low as 8 3/16 on Tuesday. A fall of 1/16 leaves Bath Electric Preferred shares at 11⅜. In the manufacturing group, Westinghouse Preference are steady at 3, and the Debenture stock is 92. Babcock & Wilcox hardened a fraction to 5, the Preference being also better at 1½. There was a small seller of Willans & Robinson Debenture in the market this week, and he got 75 for his stock.

Amongst other Miscellaneous shares, the chief alteration is a drop of ¼ in Electric Constructions, which brings the price to 1⅛, as it was a fortnight ago. Henley's reacted to 11½, a fall of 10s., and they now stand but 5s. over Callender's Ordinary. But Henley's Preferen e have ⅛ to 5⅜. Crompton Debentures are again in request, and have risen another 2 per cent., although Edison and Swan Second Debenture lost its small gain of last week. British Aluminium 5 per cent. Debenture improved a point to 102, the stock having been somewhat overlooked in the recent hunt for this class of investment.

Despite the excitement in the American Railroad section, the Telegraph stocks connected with the Atlantic have barely moved. The only quotable change in the Anglo-American group is a rise of ¼, to to 15¼ in Anglo "A." Indo-Europeans added £1 to their price at 53, and the meeting on Tuesday was quietly optimistic. Great Northerns keep steady at 38. Globe Ordinary receded ¼ to 10⅜. Telephone descriptions are simply firm, the National group being unaltered, and Monte Video Ordinary supplying the only noticeable feature with a small rise to 18s. 9d.

Electricity Supply stocks and shares present a solid front of unchanged quotations, and there has not been enough business doing to test the market's tendency in either direction. The new Adelaide Supply issue does not appear to have called for any letters of regret, although the company was kindly spoken of. The subsidence of the scare which was felt by some of the shareholders in the Metropolitan Companies by reason of the new Power Bill, has already been chronicled in these columns, but it is curious to notice that the price of Edmundson's still remains dull. The Kalgoorlie Electric Power and Lighting Co. draws attention to the fact that the profit for last year—viz., £18,344—is nearly double that of the preceding twelvemonth. The Preference shares are about 15s. middle.

Coventry Electric Tramways Co.—A dividend of 2 per cent. for the year 1904 is recommended, and the transfer of £500 to reserve, leaving £846 to be carried forward.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1903.	1904.	1904.	Closing Quotations April 17th.	Closing Quotations April 26th.	Business done week ended April 26th, 1905. Highest	Lowest
34,800	African Direct Telegraph, 4 % Debs.	100	4 %	4 %	4 %	99 —102	99 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	2¼ — 2⅜	2¼ — 2⅜	..	..
119,700‡	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	74 — 77	72 — 77	..	..
763,590	Anglo-American Telegraph	Stock	60/6	61s.	2s 6d	£0 — 62 xd	60 — 64 xd	..	..
3,118,210	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5⅝%	104 —107 xd	106 —107 xd	106	..
3,118,210	Do. do. do. Deferred	Stock	1/-	2s.	Nil	15⅛ — 15⅝	15⅝ — 15⅝	15⅝	15½
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	..	6⅝ — 6¾	6⅝ — 6¾	..	..
15,000,000$	Commercial Cable	$100	8 %	8 %	8 %	230 —240	230 —240	..	..
1,932,856‡	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	4 %	4 %	4 %	97 — 99	97 — 99 xd	98½	..
16,000	Cuba Telegraph	10	6¼%	6 %	5 %	8⅝ — 9	8½ — 9	..	..
6,000	Do. 10 % Pref.	10	10%	10%	10%	16½ — 17½	16½ — 17½	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	8⅜ — 8⅝	8⅜ — 8⅝	..	..
6,000	Do. do. 10 % Cum. Pref.	5	10%	10%	10%	8¼ — 9	8⅜ — 9	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	101 —103%	101 — 103	..	..
60,710‡	Direct United States Cable	20	5⅛%	5 %	..	11¼ — 11½ xd	11¼ — 11½xd	..	..
78,500	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	100 —102	100 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	139 —142 xd	139 —142 xd	141	139½
2,000,000	Do. 3½ % Pref. Stock	100	3½%	3½%	..	91 — 93 xd	91 — 93 xd	92⅜	91⅛
1,886,814	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	108 —110	108 —110	..	..
400,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	14 — 14½	14 — 14½	14 7/16	..
602,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	105 —107	105 —107	106½	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	4 %	4 %	4 %	100 —102	100 —102	..	..
200,000‡	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	101 —103	101 —103	..	..
180,887	Globe Telegraph and Trust	10	£3 1s 4d	5⅛%	..	10⅜ — 10⅝	10¼ — 10½	10⅜	10 5/16
180,887	Do. do. 6 % Pref.	10	6 %	6 %	..	14⅜ — 14⅝	14⅜ — 14⅝	14 7/16	14 5/16
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	24 %	37 — 39	37 — 39	..	..
50,600	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	100 —102	100 —102	..	..
17,000	Indo-European Telegraph	25	10%	10 %	13 %	51 — 53	52 — 54	..	..
72,680	Monte Video Telephone Co., Ltd., Ord.	1	3 %	3 %	..	⅞ — 1	⅞ — 1	..	..
1,988,888	National Telephone, Pref. Stock	100	6 %	6 %	6 %	108½ —109½	108½ —109½	109¼	108½
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	100 —102	100 —102	101½	100½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12¼ — 13¼	12¼ — 13¼	12¼	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11¼ — 12¼	11¼ — 12¼	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5¼ — 5⅜	5¼ — 5⅜	5 5/16	5 1/16
4,000,000	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	100 — 102	100 — 102	..	..
1,989,593	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103¼—105½	103¼—105½	104½	103½
179,318	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6½%	6½%	1⅛ — 1⅜	1⅛ — 1⅜	..	..
50,000	Do. do. 6 % Cum. Pref.	1	6 %	6 %	6 %	1 7/16 — 1 7/8	1 7/16 — 1 7/8	..	..
100,000	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	99 —102	99 —102	..	..
11,889‡	Reuter's	8	5 %	5 %	..	8 — 8¼	8 — 8¼	..	..
3,237	Submarine Cables Trust	Cert.	6 %	6 %	6 %	122 —125 xd	122 —125	..	..
58,000	United River Plate Telephone	5	7 %	8 %	..	7 — 7⅛	7 — 7⅛	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	..	5 — 5⅛	5 — 5⅛	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	107 —109	107 —109	..	..
16,509‡	West African Telegraph, Shares	10	9 %	4 %	..	8 — 8¼	8 — 8¼	..	..
80,008	West Coast of America, 1 to 80,000 and 53,001 to 53,008	2½	Nil	Nil	..	7/16 — 1/2	7/16 — 1/2	..	..
150,000	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	4 %	4 %	4 %	100 —102	100 —102	..	..
107,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	13⅜ — 14	13⅜ — 14	13 13/16	13½
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	101 —103	101 —103	..	..
563,390	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103 —105	103 —105	..	..
28,221	West India and Panama Telegraph	10	Nil	Nil	..	1⅛ — 1⅜	1⅛ — 1⅜	..	..
94,568	Do. do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	..	8¼ — 8½	8¼ — 8½	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	..	8 — 8½	8 — 8⅝	..	..
80,000‡	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	103 —105	103 —105	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

42,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	4⅜ — 5⅛	4⅜ — 5⅛	5 3/16	..
10,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	4⅜ — 5⅛	4⅜ — 5⅛	..	..
500,000‡	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	99 — 103	100 —104	..	..
133,301	British Electric Traction	10	6 %	6 %	..	9½ — 9⅝	9½ — 9⅝	9 7/16	9⅜
156,437	Do. do 6 % Cum. Pref.	10	6 %	6 %	..	10⅜ — 11⅛	10⅜ — 11⅛	11 1/16	10⅜
1,000,000‡	Do. do. 5 % Perpetual Debenture Stock	Stock	5 %	5 %	5 %	120 — 124	120 —122	..	..
250,000	Do. do. 4½% 2nd Deb. Stock Red.	100	..	..	4½%	98 — 100	98 — 100	..	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	5½ — 6	5½ — 6	5 7/16	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	5½ — 6	5½ — 6	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	101 —104	101 —104	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	⅞ — 1⅛	⅞ — 1⅛	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	1⅞ — 2	1⅞ — 2	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	1⅞ — 2	1⅞ — 2	..	..
195,000‡	Do. do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	92 — 95	92 — 95	..	..
195,000‡	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	79 — 82	79 — 82	..	..
85,000	Callender's Cable Construction shares	5	15 %	12½%	..	11 — 11½	11 — 11½	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	5 %	5 %	..	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	..
300,000	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	107 —109	107 —109	..	..
1,963,208	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	92 — 94	92 — 94	93	92½
623,396	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	101 —103	101—103	..	..
629,346	Do. do. Def. do.	Stock	4 %	4 %	4 %	82 — 85	82 — 85	..	..
1,250,000	City and South London Railway	Stock	3½%	2½%	2½%	43½ — 44½	43 — 44	43½	43
85,000	Crompton & Co., Nos. 1 to 85,000	1	5 %	2½%	..	2 — 2¼	2 — 2½	..	..
100,000‡	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	5 %	5 %	5 %	93 — 98	95 —100	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	Nil	..	1 — 1½	1 — 1½	..	..
17,189	Do. do. "A" shares, 01—017,189	5	Nil	Nil	..	1½ — 2¼	1½ — 2¼	..	..
344,023‡	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	80 — 85	80 — 85	..	..
100,000‡	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	85 — 90	84 — 89	..	..
112,100	Electric Construction 1 to 112,100	2	8 %	4 %	..	1½ — 1¾	1 — 1½	..	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	..	2¼ — 2½	2¼ — 2½	..	..
210,000	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	4 %	4 %	4 %	97 — 99	97 — 99	97½	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9¾ — 10	9¾ — 10	..	..
300,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	97 —101	97 —101	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	15 %	15 %	11¼ — 12¼	11 — 12	..	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	5⅛ — 5⅝	5⅛ — 5⅜	5⅜	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	109 —111	102 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10%	..	16 — 17	16 — 17	..	..
200,000‡	Do. do. do. 4 % 1st Mort. Deb.	100	4 %	4 %	4 %	100—103	100 —103	..	..
97,500	‡Liverpool Overhead Railway, Ord.	10	12½	12½%	11½%	3 11/16 — 3 13/16	3 11/16 — 3 13/16	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	9½ — 9¾	9½ — 9¾	..	..
87,850	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	36 — 38	36 — 38	36½	..
150,000‡	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	103 —105	103 —105	..	..
640,000‡	Waterloo & City Railway, Ord. Stock	100	3⅛%	3⅛%	3⅛%	92 — 94	92 — 94	93½	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List

Bank rate of discount 2½ per cent. (March 9th, 1905).

SHARE LIST OF ELECTRICAL COMPANIES (continued).— ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years 1902.	1903	1904.	Closing Quotations April 17th.	Closing Quotations April 26th.	Business done week ended April 26th, 1905. Highest	Lowest
£9,877	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	‡ £5	8 %	10 %	10 %	9½ — 10½	9½ — 10½	..	..
10 623	Do. do. 7 % Cum. Pref. ..	£5	7 %	7 %	7 %	9½ — 10½	9½ — 10½	..	..
£88,782	Central Electric Supply 4 % Guar. Deb. Stock	£100	4 %	4 %	4 %	105 —108	105 —108	..	..
80,000	Charing Cross and Strand Electricity Supply	£5	10 %	8 %	8 %	7⅞— 8⅛	7⅞— 8⅛	8 1/16	7⅞
80,000	Do. do. do. 4½% Cum. Pref. ..	£5	4½%	4½%	4½%	5⅜— 5⅝	5⅜— 5⅝	5⅝	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	£5	4½%	4½%	4½%	5 — 5⅛	5 — 5⅛	5	..
40,000	Do. do. 1903	£5	..	4½%	4½%	5 — 5⅛	5 — 5⅛	..	..
350,000	Do. do. 4 % Deb. Stock Red.	£100	4 %	4 %	4 %	105 —107	105 —107	106	..
44,486	*Chelsea Electricity Supply, Ord.	£5	4½%	5½%	6 %	6½ — 7	6½ — 7	6⅝	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	4½%	4½%	4½%	109 —111	109 —111	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110.595	£10	5 %	5 %	6 %	11 — 12	11 — 12	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	£10	6 %	6 %	6 %	12½ — 14	13½ — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	5 %	5 %	5 %	123 —127	123 —127	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	£100	4½%	4½%	4½%	103 —105	103 —105	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	£10	4 %	4 %	4½%	9 — 9½	9 — 9½	9	..
83,000	Do. do. do. 6 % Pref., 40,001—60 ..	£10	6 %	6 %	6 %	12 — 12½	12 — 12½	12½	..
400,000‡	Do. do. 4½% Deb. Stock	..	4½%	4½%	4½%	111 —114	111 —114	..	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	4½%	4½%	4½%	104 —106	104 —106	105	..
70,000	Edmundson's Electric Corporation, Ord. Shares	£5	7 %	7 %	..	5⅞— 6⅛	5⅞— 6⅛	..	..
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	..	6⅛— 6⅜	6⅛— 6⅜	6 1/16	6⅛
800,000‡	Do. do. 4½% 1st Mort. Deb. Stock ..	£100	4½%	4½%	4½%	106 —108	106 —108	105½	..
91,000	Kensington and Knightsbridge Electric Ord.	£5	10 %	12½%	12 %	12 — 13	12 — 13	..	..
136,000	Do. do. do. 4 % Debenture Stock ..	Stock	4 %	4 %	4 %	101 —103	101 —103	..	..
411,000	London Electric Supply Corporation, Limited, Ord.	£3	Nil	Nil	3 %	2½— 2¾	2½— 3⅛	..	..
60 000	Do. do. do. 6 % Pref.	£5	6 %	6 %	6 %	5¼— 5⅜	5¼— 5⅜	..	..
371,845	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	4 %	4 %	4 %	99 —101	99 —101	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	£10	7½%	8⅝%	10 %	17½— 18½	17½— 18½	18⅜	18½
76,121	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	£5	4½%	4½%	4½%	5⅜ — 5⅞	5⅝ — 5⅞	5 15/16	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	4½%	4½%	4½%	109 —114	109 —114	..	..
950,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	3½%	3½%	3½%	97 — 99	97 — 99	99⅜	98
200,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	99 —101	99 —101	..	..
10,852	Notting Hill Electric Lighting	£10	6 %	6 %	7 %	14½— 15½	14½— 15½	..	..
59,000	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	100 —102	100 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	£5	14½%	14½%	14½%	13½— 14½	13½— 14½	14⅜	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	£5	7 %	7 %	7 %	8½— 8¾	8½— 8¾	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	£100	3½%	3½%	3½%	98 —100	98 —100	99½	..
12,000	Smithfield Markets Electric Supply, Ord.	£5	4½%	4 %	4 %	2⅝— 3⅛	2⅝— 3⅛	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	79 — 83	79 — 83	..	..
65,000	South London Electricity Supply, Ord.	£5	1¾%	3 %	4 %	3⅜— 4¼	3⅜— 4¼	..	..
100,000	South Metropolitan Electric Light and Power Ord.	£1	Nil	Nil	Nil	⅞— 1	⅞— 1	..	..
50,000	(Late Blackheath and Greenwich 7 % Pref.	£1	Nil	7 %	7 %	1 1/32— 1 1/32	1 1/32— 1 1/32	..	..
100,000	Dist. E.L.Co.) 4½% 1st Deb. Stock	£100	4½%	4½%	4½%	105 —108	105 —108	..	..
80,000	Urban Electric Supply, Ord.	£5	5 %	5 %	5 %	4½— 5 1/16	4½— 5 1/16	4 15/16	..
80,000	Do. do. 5 % Cum. Pref.	£5	5 %	5 %	5 %	5 — 5¼	5 — 5¼	5⅛	..
200,000	Do. do. 4½% 1st Mort. Deb. Stock Red ..	100	..	..	4½%	104 —106	104 —106	105½	..
110,000	Westminster Electric Supply, Ord.	£5	12 %	13½%	14%	12¾— 13¾	12¾— 13¾	12 13/16	12¾
98,151	Do. do. 5 % Cum. Pref.	£5	5 %	5 %	5 %	6 — 6¼	6 — 6¼	6	..

Shares not officially quoted :—Mackay Companies, ord., 41—41½. Pref. 75—75½.

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	£*	No. of wks.	Total to date. £	£*	Miles open.	*
Aberdeen	Apr. 22	2,251	— 187	47	61,876	+ 5,360	..	..
Ayr	,, 15	446	— 38	48	13,631	+ 635	..	..
Bath	,, 19	1,1 9	— 100	16	8,875	+ 321	12½	..
Birkenhead	,, 23	1,989	— 34	3	3,290	— 94	13·5	..
Blackburn	..	..	..	..	..	..	13½	..
Blackpool	,, 20	832	— 206	3	1,296	— 1,166	6½	..
,, —Fleetw'd	,, 22	768	+ 178	16	3,547	— 497	..	..
,, —Lytham	,, 6	364	— 402	23	3,152	..	7½	..
Bolton	,, 23	4,180	+ 576	4	6,706	+ 115	25	..
Bournemouth ..	,, 19	1,985	— 328	2½	2,665	..	15·15	..
†Bradford	,, 8	3,932	— 873	1	4,844	+ 843	56	..
Brighton	,, 23	1,871	+ 146	4	2,943	..	9½	..
Bristol	,, 21	9,315	— 487	..	..	..	..	..
Brit. Elec. Trac. Co.								
Airdrie	Apr. 14	390	+ 6	15	2,889	+ 4	..	..
Barnsley	,, 14	314	— 60	,,	2,281	— 15	..	..
Barrow	,, 14	430	+ 84	,,	2,830	+ 476	..	..
Birmingham (City)	,, 14	‡11,458	+ 82	,,	‡80,857	+ 4,383	..	..
Birmingham (Mid.)	,, 14	‡3·830	+ 368	,,	‡25,421	+ 3,299	..	..
Devonport ..	,, 14	979	— 77	,,	6,479	— 348	..	..
Dudley—Sto'rb'ge	,, 14	1,628	— 269	,,	11,344	+ 122	..	..
Gateshead	,, 14	1,781	— 43	,,	12,926	+ 154	..	..
Gravesend, N'fleet	,, 14	419	— 152	,,	2,·44	— 400	..	..
Gr'n'k, Pt. Glsgw	,, 14	1,288	+ 234	,,	8,035	+ 1,169	..	..
Hartlepool ..	,, 14	469	— 96	,,	3,583	— 84	..	..
Kidderminster ..	,, 14	199	— 80	,,	1,372	— 107	..	..
Merthyr	,, 14	391	— 91	,,	2,654	— 242	..	..
Metropolitan ..	,, 14	‡4,191	+1,419	,,	‡29,168	+ 12,320	..	..
Middleton	,, 14	602	— 67	,,	4,011	+ 233	..	..
Oldham — Ashton	,, 14	1,040	— 99	,,	7,346	— 23	..	..
Peterborough ..	,, 14	224	— 93	,,	1,558	— 171	..	..
Poole	,, 14	506	— 226	,,	3,870	— 274	..	..
Potteries	,, 14	3,343	— 119	,,	24,375	+ 420	..	..
Rothesay	,, 14	140	— 129	,,	722	— 96	..	..
Sheerness	,, 12	126	+ 8	,,	830	+ 143	..	..
Southport	,, 14	513	— 216	,,	3,487	— 267	..	..
South Staffs. ..	,, 14	1,357	— 317	,,	9,710	— 729	..	..
Swansea	,, 14	963	— 153	,,	6,923	+ 31	..	..
Taunton	,, 14	99	— 43	,,	621	— 97	..	..
Tynemouth ..	,, 14	874	— 185	,,	2,588	— 575	..	..
Weston-s-Mare ..	,, 12	103	— 65	,,	468	— 3	..	..
Wolverhampton D.	,, 14	707	— 158	,,	5,122	+ 49	..	..
Worcester	,, 14	582	— 61	,,	3,844	+ 760	..	..
Wrexham	,, 14	215	— 74	,,	1,418	— 115	..	..
Yorks. Wool. Dist.	,, 14	1,201	— 146	,,	8,432	+ 680	..	..
Burnley	Apr. 22	2,405	+ 425	..	..	..	..	..
Burton-on-Trent ..	,, 23	6.7	— 11	3	1,025	..	8½	..
†Bury	,, 9	534	..	1	786	..	..	..
†Cardiff	Apr. 8	1,897	— 297	1	2,324	— 514	..	..
Carlisle	,, 22	370	— 7	16	2,413	— 388	..	..
Chatham and Dist.	,, 20	1,249	+ 98	16	9,388	+ 984	9·3	+ ·8
Colchester	,, 19	342	..	38	8,184	..	18 75	..
Cork	,, 13	894	— 2	15	6,127	+ 223	9·9	..
Darlington	,, 15	368	..	2	868	..	4·87	..
Darwen	,, 22	498	+ 70	3	726	— 11	4·36	..
Dover	,, 15	364	— 83	15	2,529	— 171	3	..
Dublin	,, 21	9,215	— 275	..	70,675	+ 651	48	+ 1
Dundee	,, 19	1,629	— 95	..	..	..	..	..
East Ham	,, 22	1,548	+ 89	3	2,452	..	..	..
Glasgow	,, 22	29,781	+ 849	46½	670,563	+34,925	78½	+ 3
Gloucester	,, 19	526	..	3	726	..	15	..
†Halifax	,, 5	1,078	— 593	1	1,078	— 593	35½	+ 2½
Huddersfield ..	,, 22	2,518	+ 145	3	4,053	— 187	..	..
Hull	,, 22	4,274	+ 200	3	6,843	— 187	13	..
Ilford	,, 15	509	— 248	2	909	— 248	..	..
Ilkeston	,, 12	223	— 82	2	223	— 82	3·5	..
Ipswich	,, 22	845	+ 23	3	1,245	— 284	10½	..
Isle of Thanet ..	,, 22	842	— 9	16	4,406	— 196	..	..
Kirkcaldy	,, 19	403	— 83	..	..	..	..	..
Lan'kshire Trm. Co.	,, 20	1,296	— 52	16	10,079	+ 722	8·6	..
Leeds	,, 15	10,918	— 391	3	16,389	+ 115	89½	+ 7½
Leicester	,, 15	3,966	..	15	27,418	..	..	..
Liverpool	,, 15	20,852	+ 425	15	149,907	+ 6,238	103	..
†L.C.C.	,, 8	13,405	+1,635	1	15,943	+ 2,324	47½	+ 7½
Lowestoft	,, 15	247	— 93	..	..	..	..	..
Manchester	,, 22	24,786	+1,719	3	36,768	+ 1,574	..	..
Newcastle	,, 22	7,313	+ 420	..	..	..	..	..
Newport	,, 18	1,107	+ 98	2	1,107	+ 98	14½	+ 1½
Oldham	,, 16	2,987	+ 688	3	5,089	+ 1,051	23	+ 5½
Plymouth	..	..	..	2	..	..	..	..
Pontypridd	,, 15	319	..	2	570	..	3·5	..
Portsmouth	,, 15	3,618	—1,229	2	3,618	— 1,229	14½	..
Reading	,, 13	1,087	..	2	1,087	..	13·12	..
Rochdale	,, 15	1,166	+ 860	2	1,166	+ 860	15·4	10·8
Salford	,, 24	8,789	+ 956	4	14,579	+ 216	80	..
Scarborough ..	,, 15	147	..	14	954	..	3½	..
Sheffield	,, 23	9,172	+ 226	4	18,918	— 720	84½	+ 1½
Southampton ..	,, 19	1,710	— 156	3	2,579	— 845	16·6	..
Southend-on-Sea ..	,, 19	525	— 2	3	722	— 120	6½	..
Stockport	,, 14	955	— 200	2	955	— 200	11½	+ 1
†Sunderland	,, 23	1,188	+ 13	3	3,725	— 333	21	+ 1
Tyneside	,, 19	677	+ 60	16	5,318	+ 671	..	..
†Warrington	,, 6	319	— 33	1	319	— 33	7½	..
West Ham	,, 20	2,270	+ 625	3	3,458	+ 1,206	9·78	+5·2
Wolverhampton ..	,, 19	889	+ 330	3	1,953	..	..	..
Cen. London Rly.	Apr. 22	12,977	— 158	16	113,342	+ 2,003	6	..
City & S. Lon. Rly.	,, 23	5,284	— 198	17	49,686	— 2,734	6½	..
Dublin-Lucan Rly.	,, 21	238	+ 5	16	1,575	+ 2	7	..
G. N. and City Rly.	,, 22	3,011	+1,188	16	25,499	..	3½	..
L'pool Overh'd Rly.	,, 23	3,008	— 239	16	25,092	— 1,268	6·57	..
†Mersey Railway ..	,, 15	1,630	+ 72	15	23,874	+ 1,361	4½	..

* Compared with the corresponding period of 1904. † One week only. ‡ ncludes horse and other receipts.

EXPORTS AND IMPORTS OF ELECTRICAL GOODS DURING MARCH, 1905.

Our monthly return of electrical exports and imports of the United Kingdom shows a satisfactory increase in the case of the former, viz., £114,533, as compared with £98,965 in the shorter month of February; this is also true of the imports, which are some £8 000 in excess of last month; the re-exports, however, have diminished by some £2,000.

Owing to the small extent of the telegraphs exports and imports, these are entered as separate items below the tabulated returns; practically the whole of the former, it may be noted, is composed of Marconi apparatus.

In comparing the individual items with the February returns, t will be seen that the marked improvement during the present month lies in exports and imports of electrical machinery, and that while India remains our most prominent customer, our South African Colonies, Japan, China and New Zealand compete closely for second place.

The value of electrical machinery imports so far this year shows a falling off, compared with 1904, the returns for the three months ending with March indicating a total of only £126,498, which contrasts with £139,336 in the first quarter of 1904.

Registered Exports of British and Irish Electrical Goods from the United Kingdom.

Country receiving exports and importing.	Electrical goods and appliances.	Electric light and power cable.	Electric lighting fittings and accessories.	Electric lamps.	Electric meters and instruments.	Electric machinery.	Batteries and accumulators.	Carbons.	Telephone material and electric bells.	Electrically-driven machinery.	Tramways apparatus and materials.
	£	£	£	£	£	£	£	£	£	£	£
Russia, Sweden, Norway and Denmark	135	...	41	72	66	342	270	...	24	231	...
Germany	65	...	...	14	...	255	...	...	78	306	...
Netherlands...	212	881	459	...	20	130	32	10	12	...	...
Java, Dutch Borneo and Dutch Indies	5	...	49	3	...	...	...	...	...	...	...
Belgium	50	33	24	2	77	15	87	...	99	...	...
France	644		112	...	...	1,026	1,260	...	...	200	...
Portugal, Madeira, and Portuguese Africa ...	2	70	88	...	15	435	...	...	1,604	203	...
Spain and Canary Isles	...	...	43	...	...	2 692	...	...	...	...	...
Italy	68	...	...	...	1,069	220	3	...	15	...	...
Austria-Hungary and Greece	9	...	...	...	41	...	...	...	...	...	...
Egypt	1,007	83	110	10	50	1,133	59	...	211	...	...
China and Siam	1,589	27	210	34	...	208	...	...	...	141	...
Japan	975	1,872	...	...	...	8,484	...	...	1,850	324	...
U.S.A., Philippines and Cuba	74	...	22	44	149	332	...	...	...	...	...
Mexico, Peru and Uruguay	...	26	50	...	...	260	...	...	...	790	...
Chili	26	193	224	...	75	95	22	...	...	...	...
Brazil	3	8	570	47	...	1,096	27	13	143	...	...
Argentine	1,530	344	344	...	170	3,119	686	...	52	...	1,000
Channel Isles, Gibraltar and Malta	296	354	...	...	12	198	159	...	...	...	...
British West Africa	3	195	11	159	5	10	...	...	148	9	...
Cape of Good Hope	1,203	2,461	380	197	462	4,115	40	42	848	562	93
Natal...	745	1,761	779	819	214	1,894	279	...	2,826	4,647	...
Zanzibar, British East Africa, Mauritius and Aden	166	...	10	10	...	141	7	65	14	...	...
India...	2,883	2,612	3,365	871	721	3,647	559	141	492	515	668
Burmah	22	...	51	115	...	243	1	3	15	99	4
Ceylon	221	...	250	58	9	8	18	...	3	18	...
Straits Settlements and Sarawak	111	1,538	202	16	201	75	2	...	97	10	34
Hong Kong	314	547	164	39	10	...	...	...	9	114	...
West Australia	203	296	36	350	749	2,098	...	...	...	...	...
South Australia	...	165	93	...	...	277	31	...	...	...	...
Victoria	905	1,947	...	...	68	1,599	...	...	2,335	...	...
New South Wales	471	589	112	174	91	3,905	146	9	...	...	65
Queensland	30	...	...	...	...	81	...	...	...	...	...
Tasmania	57	314	...	...	...	...	...	...	...	...	...
New Zealand	1,343	54	387	30	559	538	144	19	8	...	...
Canada and Newfoundland	50	...	53	...	10	136	25	...	...	...	...
British West Indies and British Guiana ...	157	...	...	...	...	19	26	...	16	...	...
Total, £	15 273	16 050	8,249	3,034	4,843	38,796	3,883	292	10,899	8 169	1,864

Telegraph exports for month, Russia, £3,220; Natal, £11.

Registered Re-Exports of Foreign and Colonial Electrical Goods from the United Kingdom.

Various countries, mainly as above.	£ 1,334	£ 33	£ 357	£ 97	£ 277	£ 3,404	£ 88	£ 11	£ 2,854	£ 7	£ ...

Registered Imports into the United Kingdom of Electrical Goods from all Countries.

Russia, Sweden, Norway and Denmark... ...	£ 82	£ ...	£ 50	£ ...	£ ...	£ 2,438	£ 201	£ ...	£ 11,500	£ ...	£ ...
Germany	2 314	2,856	972	202	...	2,795	578	190	788	2,173	...
Holland	5,047	1,445	4,945	70	...	9,104	...	7,266	...	...	...
Belgium	8 479	1,333	153	85	24	11,068	49	1 089	1,081	65	...
France	10,384	673	550	168	620	2,360	1,338	1,808	1,633	...	...
United States	10,720	101	52	1,493	269	18,374	...	14	200	1,169	...
Total, £	37,026	6,408	6,722	2,018	913	46,139	2,166	10 367	15,202	3 407	

Additional Imports.—Austria, electrical machinery, £20; Cape of Good Hope, telegraph material, £137.

Total Exports: £114,513.

Total Re-Exports: £8,462.

Total Imports: £130,525.

Note.—The amounts appearing under the several headings are classified according to the Customs returns. The first and third columns contain many amounts relating to "goods" otherwise unclassified, the latter, doubtless, consisting of similar materials to those appearing in adjacent columns.

INSTITUTION OF ELECTRICAL ENGINEERS.

LOW-TENSION THERMAL CUT-OUTS.

By Alfred Schwartz and W. H. N. James.

(*Abstract of paper read at Manchester, March 14th, 1905.*)

The three types of circuit in which fuses are employed are given below, together with the general order of magnitude of the currents to be dealt with:—

1. Distributor boards	3 to 30	amperes
2. House services and switchboards ...	10 to 100	"
3. Motor services and section pillars on distributing mains	50 to 500	"

The current required to fuse a wire of circular cross-section of given material is dependent upon the following variables:—(1) Diameter; (2) time of current flow; (3) length of fuse wire employed; (4) environment and position of fuse; (5) previous history of fuse wire.

It will be seen that there may be an infinite number of fusing currents for any particular wire. The "normal fusing current" for a given wire, the length and environment of which are constant, may be defined as the minimum current required to fuse the wire in such a time interval as shall be necessary for the wire to have attained its maximum steady temperature. The "normal carrying capacity" or "rating" of a fuse wire may be defined as the maximum current which the fuse is capable of carrying continuously without deterioration or undue heating. It should, in the author's view, be taken as one-half of the normal fusing current for tinned copper wires.

The first series of experiments undertaken by the authors was for the purpose of determining whether a law of the character $C = A\,d^b$ connecting the fusing current (C) and the diameter (d) was true over any considerable range. In these experiments commercial tinned copper wires, fusing with currents from 1 to 100 amperes, were employed. These wires were supported horizontally, and were of such lengths that the fusing currents were independent of the cooling effect of the terminals. In each case the current was increased slowly, and the wire allowed to reach a steady temperature before rupture took place. The authors' results for pure copper and tinned copper are practically coincident; this is due to the small quantity of tin employed in the coating. In common with wires of lead and tin and their alloys, aluminium wires, particularly in the smaller diameters, are considerably affected as to their fusing current by the action of the atmosphere. A layer or skin of oxide or carbonate is formed of sufficient thickness and strength to hold up the metallic core of the wire when in a molten condition. Such wires break by the molten metal draining from the upper to the lower portion of the wire; the fusing current is, consequently, abnormal. With aluminium wire this skin is particularly tough, and has a large effect upon the fusing current.

In the case of fuses enclosed in tubes packed with sand, chalk, asbestos, or other incombustible material, this effect is naturally intensified, as the molten wire is closely supported on all sides, and special means have to be adopted to overcome the difficulty thus introduced. Preece's index of 1·5 does not fit the curves of experimental results; Preece states that his law gives values for C which are too low for small diameters, but we find that his values are also too high for the larger diameters. Determining the law for tinned copper over a large range (1 to 100 amperes), the best values of A and b are contained in the formula,

$$C = 1{,}435\ d^{1\cdot527} \quad (d \text{ in cm}).$$

The above law gives somewhat low values for wires of large diameter. The current range from 1 to 100 amperes was, therefore, divided into two parts, 1 to 10 amperes and 10 to 100 amperes, and the best law found for each case, with the following results:—

Range 1 to 10 amps. $C = 821{\cdot}3\ d^{1\cdot195}$.
" 10 to 100 " $C = 1{,}768\ d^{1\cdot403}$.

The calculated and observed values are practically in agreement. For diameters in inches the law is expressed as follows for horizontal wires:—

Range 1 to 10 amps. $C = 2{,}501\ d^{1\cdot195}$.
" 10 to 100 " $C = 6{,}537\ d^{1\cdot403}$.

The values of the index and constant necessary for use with various metals, with the diameters in inches and centimetres for wires in vertical or horizontal positions, with large and small terminals, and for certain standard lengths, are given in tabular form in the appendix.

For copper wires the effect of being in a vertical position instead of a horizontal one is to decrease the fusing current by 5 or 6 per cent. This is best expressed in the formula by keeping the index constant and altering the constant.

The effect of shortening the fuse wire is to increase the index and the constant.

A number of experiments were made with tinned copper wires to determine the relation between fusing current (C) and length (l), and on plotting fusing currents as ordinates and $\frac{1}{l}$ as abscissæ, a straight line over a considerable range was obtained. This corresponds to a law of the form $C_l = M + \frac{N}{l}$, where M and N are constants depending on the diameter, and l is the length of wire employed.

It was found that $M = P\,C_n$ and $N = Q\,d^2$, where P and Q are constants for a given material with terminals of a definite mass and independent of the diameter of the wire.

C_n = normal fusing current for wires sufficiently long to be independent of the cooling effect of the terminals.

C_l = fusing current for a wire of length l cm.

The mean values for tinned copper are as follows:—$P = {\cdot}864$, $Q = 19{,}000$; so that the fusing current C_l for a length of l cm. of tinned copper wire may be obtained from the formula

$$C_l = {\cdot}864\ C_n + \frac{19{,}000\ d^2}{l},$$

C_n being the normal fusing current as previously defined.

For lead

$$C_l = {\cdot}813\ C_n + \frac{2{,}083\ d^2}{l}.$$

The effect of the length of wire employed and the mass of the terminals is much greater in the case of lead than in the case of copper, owing to the increased cross-sectional area required for a given current-carrying capacity; the radiating surface being directly proportional to d, while the surface available for the conduction of heat along the wire is proportional to d^2.

With copper wires with fusing currents up to 10 amperes and lengths of 2 in. and upwards the effect of terminals may be neglected.

With copper strip the fusing current is proportional to the breadth, with a constant thickness.

A law of the character $C = Ab\,(t + k)$ obtains, where C = fusing current, b = breadth, t = thickness. With a length of 5½ inches, and the breadth and thickness in inches, the strip being vertical,

$$C = 40{,}550\ b\ (t + {\cdot}00355).$$

In centimetre measure

$$C = 6{,}280\ b\ (t + {\cdot}009).$$

The effect of position is more marked in the case of strips than in the case of wires, the decrease in fusing current due to vertical position *vice* a horizontal position being about 10 per cent. for strips.

The fusing current for vertical lead strips is given by the following equation:—

$$C = 2{,}060\ t^{\cdot74}\ (b + {\cdot}016);\ b \text{ and } t \text{ in inches.}$$

The range of experiments from which this law was deduced was as follows:—Thickness ·0055 in. to ·055 in. Breadth ·08 in, to ·4 in. Fusing currents 4 amperes to 100 amperes.

This formula can be relied on to within 3 per cent. with good commercial lead. An analysis of the sample used gave 99·8 per cent. of lead.

In centimetre measure, $C = 407\ t^{\cdot74}\ (b + {\cdot}04)$.

A series of experiments was carried out with a No. 33 S.W.G. tinned copper wire, free in air from terminal to terminal. The wire was placed along the axis of a tube, which extended the whole length of the wire, the ends of the tube being left open. Tubes of glass and of brass were employed, with internal diameters varying from 0·4 to 2·6 cms., the tubes being arranged vertically and also horizontally. In each case there was a certain size of tube for which the fusing current was a minimum, any departure from this size of tube with the size of wire employed producing an increase in the fusing current.

Tin is the most economical metal to use in respect of power expended; then come silver, aluminium (with spring attachment), copper and aluminium (without spring) in the order named.

It would seem desirable to run copper fuses at 50 per cent. of their *normal fusing current* rather than at a higher rate. The temperature attained under normal load will then be moderate, and oxidation will be slight. On the other hand, fuses rated to blow with an excess current of 50 per cent. of their *normal carrying capacity* get far too hot, and oxidise to such an extent as to require frequent inspection and renewal.

The authors' experiments on copper fuses show that in general an average drop of 0·15 volt may be reckoned on, per fuse way at full load. In an ordinary house installation we may assume that the current for any particular lamp will have to pass through three double-pole fuses on its journey from the supply company's mains to the lamp in question; the total pressure drop in the fuses will therefore be $3 \times 2 \times 0{\cdot}15 = 0{\cdot}90$ volt—a drop which certainly should not be neglected when considering the total drop in volts in the circuit. Fuses immersed in oil have a large drop in volts in them on account of the high current density at which they are run. The oil in such cases gets extremely hot, and, in the authors' opinion, no cut-out in which the fuse wire itself is in contact with or immersed in oil before fusion has taken place, should be permitted.

Generally speaking, the capacity of the circuit for overload is considerably in excess of the overload capacity of the fuse which protects it; there are cases, however, which require special treatment. Arc lamps, for instance, are difficult to deal with.

With regard to motors, the matter is somewhat simpler; the fuse should be set for 100 per cent. excess over the normal working full load current; it will then be able to stand the variations in current likely to occur and to protect the leads from over-heating.

Fig. 1 shows the relation between the percentage overload and the time taken to fuse the wire from a cold state for tinned copper wires, with normal fusing currents varying from 5 to 54 amperes and a length of 4½ in.

Fig. 2 gives a comparison between the overload capacity of wires of silver, copper, aluminium, and tin. Experiments were made with tinned copper wires, No. 22 S.W.G., with a normal fusing current of 49·8 amperes, arranged horizontally ¼ in. apart,

Two wires in parallel fused at 45 amperes each, and three or more at about 43 amperes each.

It will be noticed that tin is the most sluggish, and copper and silver are the quickest in action—the two latter being practically equal.

Fig. 3 shows the effect of excessive overloads—up to 2,000 per cent.—on tin wires.

Experiments were made to determine the effect of twists, cuts, kinks, and blows on fuse wires of copper and lead. The effect is remarkably small, particularly in the case of lead wire. The same also applies to tin.

Copper wires attain a red heat with about 75 per cent. of their normal fusing current, and although oxidation commences at rather a lower temperature than this, it does not proceed rapidly unless red heat is attained. This severe oxidation at high overload will cause the fuse to act in a fairly short time if more than 60 per cent. in excess of the rated carrying capacity is used continuously.

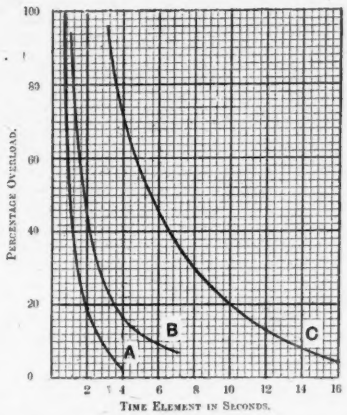


Fig 1.—Moderate overloads on tinned copper wires, the overload being taken as excess over the normal fusing current.

A, Normal fusing current of wire 5·45 amps. No. 38 s.w.g.
B, " " " 10·6 amps. No. 33 s.w.g.
C, " " " 54·0 amps. No. 21 s.w.g.

Experiments on the effect of alternating currents on fuse wires, carried out by Jackson and Ochsner, show no appreciable change.

Although a fuse may operate quite successfully on a circuit with 100 per cent. excess current, it has in practice to face the severe conditions of a short circuit.

A tinned copper fuse melting with a current about 20 per cent. in excess of its normal fusing current exhibits a greater tendency to arc than when melting under a current of four or five times this

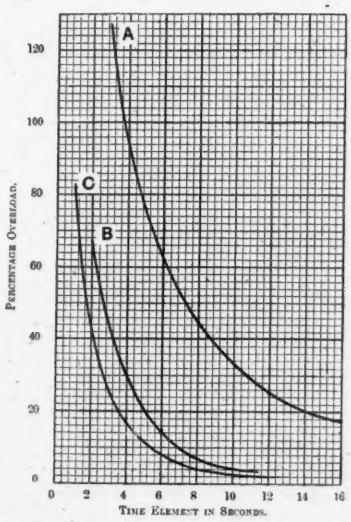


Fig. 2.—Behaviour of wires of various materials on moderate overloads, the overload being taken as excess over the normal fusing current (10 amps.).

A, Tin; B, Aluminium, with spring attachment; C, Copper and silver.

strength. Mr. H. A. Ratcliffe, of the testing department of the Manchester Corporation Electricity Works, has found that numbers of fuse fittings, which have successfully withstood a so-called short-circuit test with a current limited to seven or eight times the normal fusing current, were entirely destroyed on a direct short circuit. The fuse wire employed in these cases was tin, which, on fusing, is far more favourable to the formation of an arc than is copper. He has also found that on short-circuiting a 50-ampere fuse with an 800-ampere circuit-breaker in the circuit, the breaker has been opened. Oëlschlager has recently measured, by means of the oscillograph, the current, pressure rise, and time of fusion on short circuit in a Siemens-Schuckert cartridge fuse with a normal fusing current of 40 amperes. The circuit voltage was 110 D.C.; capacity of generators, 1,000 KW.

The resistance of the fuse wire when hot was found to be 0·017 ohm. On a short circuit, the maximum current would be 6,500 amperes. As a matter of fact, the current was found to be only 850 amperes. This is due to the natural self-induction of the circuit and the consequent relatively slow growth of the current; fusion took place long before the current could reach its theoretical maximum value. Just before the melting of the wire the pressure rose to about 25 volts. At the moment of melting an enormous rise of pressure suddenly took place, the total voltage being about 800. The actual breaking of the circuit took place in 0·00015 second, the self-induction of the circuit being of the order of 10^{-4} henry. Curves of the same character were obtained with a battery.

It is common practice to increase the length of break with the normal carrying capacity of the wire. In the opinion of the authors, the normal fusing current in copper fuses should not exceed 100 amperes per wire. Fuses for larger currents should be made up of several wires in parallel, spaced about ½ in. apart. The effectual suppression of the arc in some circumstances calls for the proximity of masses of cold material, such as porcelain, or the passage of the wire through asbestos or other incombustible material. If the wire is in contact with any such bodies for a part or the whole of its length, its fusing current will be affected to a greater or less extent.

The authors find, however, for pressures up to 220 volts, tinned copper wires in porcelain clip holders in which the wire is free in air for a length of 2½ in. between the terminals are quite satisfactory on a dead short circuit. For distribution boards the spacing should

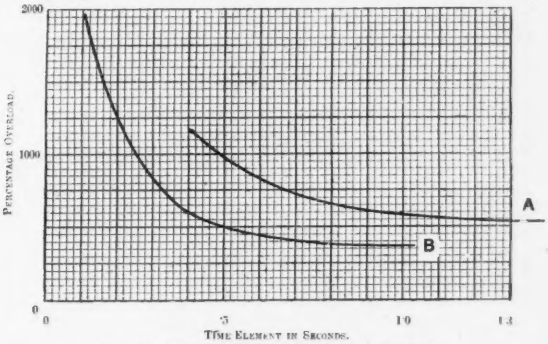


Fig. 3.—Excessive overloads on tin wires.

A, Normal fusing current of wire, 44 amps. No. 12 s.w.g.
B, " " " 21 amps. No. 16 s w g

be rather more liberal than is at present customary, and the fuses should be screened from one another by septa of incombustible material. Wherever possible the contacts and terminals should be screened from the action of the arc.

The arc is much more persistent with lead and tin than with copper, so much so that fuse fittings that will stand a direct short circuit with copper wire may be destroyed when used with tin or alloy wires.

The cooling effect of the terminals is considerably greater in the case of lead and tin than in that of copper. These metals also become very brittle at a temperature slightly below their fusing point, and they are liable to severe oxidation.

Silver is very suitable for use when enclosed, and is used very largely in Germany. Silver wires act more promptly than wires of lead or tin.

The authors strongly favour the use of tinned copper. It is easy to handle in sizes down to No. 38 s.w.g., which would be used to protect a 3-ampere circuit. It does not oxidise perceptibly when carrying 50 per cent. of its normal fusing current. With properly designed holders and fuse boxes, in which all inflammable material is entirely excluded from the sphere of action of the wire, the fire risk is practically *nil*.

Fuses should be easily removable for inspection and renewal, and be capable of being quickly replaced on a live circuit without shock or injury to the operator. This necessitates the fuse wire being mounted in a removable holder of insulating and incombustible material. Fuse wires increase considerably in length before fusion takes place, and in consequence they may come into contact with the holder. Where the enclosing tube is of vulcanised fibre a contact with the wire will lead to charring and possible firing on overloads. Semi-enclosed fuses should have the holders so constructed that any deposit of metal vapour or oxide upon them, due to the blowing of the fuse, can be easily removed. Short lengths of loosely-woven asbestos tubing, which can be slipped over the wires, and which fit them freely, give excellent results for the larger-sized tinned copper wires, damping out the arc and limiting the scattering of the molten metal; allowance, however, must be made for the effect on the fusing current.

In enclosed or cartridge fuses the wire is surrounded by a tubular sheath with closed ends; the tubes are usually loosely packed with an incombustible filling. In the packed fuse the molten wire receives a considerable amount of support from the filling material, and may retain its continuity until it is volatilised. With a short length of the wire passing through a central air chamber, the wire has a better chance of rupturing.

The Germans have developed very complete systems of cartridge fuses in which emery or French chalk is used as filling, and porcelain as the jacket material. These fuses are extremely compact, and are non-interchangeable, both for voltage and current carrying capacity.

With enclosed fuses of all kinds it is necessary to have an indicator to show whether the fuse has blown or not.

All fuse holders should be marked with their normal carrying capacity in amperes (50 per cent. of the normal fusing current), the voltage of the circuit for which they are intended and the gauge of the wire employed.

The length of clear break or the minimum distance from metal to metal of the terminals should not be less than 2½ in. for circuits up to 220 volts, with open fuses up to 20 amperes, with an additional ½ in. for every 15 amperes up to 110 amperes.

With open fuses in metal boxes the break should be at least 4½ in. For house and motor services the enclosed fuse seems to offer considerable advantages over other types where large currents are required, and with pressures up to 400 volts, their chief drawback at present being the difficulty and cost of refilling the cartridges.

The ratio between the current necessary to bring a given wire to red heat (in diffused daylight) and its normal fusing current, was found to be constant, being equal to ·75 for tinned copper wires of such length as to be independent of the cooling of the terminals.

Open type fuses in which tinned copper wire is employed, should be tested for normal fusing current in the following way:—The wire in its holder should be screened from draughts, and the current raised until the first appearance of redness at the centre of the wire is observed in diffused daylight, this is the "red heat current," and should be noted. The wire should be brought up to redness fairly rapidly—say, in half a minute. The current should then be gradually and regularly increased, allowing ample time for the wires to attain a steady temperature.

For semi-enclosed and enclosed fuses the time interval necessary to bring them up to a given temperature will depend upon the environment of the wire, and should be ascertained by experiment.

Short circuit tests on fuses should be made as far as possible under actual working conditions and with a voltage 10 per cent. in excess of the circuit voltage for which the fuse is intended.

In no case should the short circuit current be arranged for less than 400 amperes.

Wherever possible, facilities should be given at the central station or one of the sub-stations serving the district for the testing of types of fuses proposed for consumers' premises.

House service fuses should be tested with the box covers in position.

Fuses should also be tested for arcing with currents slightly in excess of their normal fusing current.

The fuse is an extremely simple device, and it is perhaps due to this fact that it has not been treated with the necessary care. All experiments with fuses should be carried out with the greatest care if accurate results are to be obtained, and the same care should be exercised in their design and installation.

APPENDIX.

TABLE OF CONSTANTS for use with the authors' formula $c = a d^n$ for determining the fusing current of wire. Wires free in air from terminal to terminal in all cases.

Particulars of fuse.	Range on S.W.G.	Range of fusing currents.	Index.	Constant.	
				Cm.	Inches.
Tinned copper:—					
2 in. and upwards, horizontal ...	47 to 33	1 to 10	1·195	821·3	2,501
6 in. and upwards, horizontal ...	33 to 18	10 to 100	1·403	1,768	6,537
2 in. and upwards, vertical	47 to 33	1 to 10	1·195	775	2,360
6 in. and upwards, vertical	33 to 18	10 to 100	1·403	1,680	6,220
4 in., horizontal with large terminals	33 to 18	10 to 100	1·586	2,980	13,100
Ditto, vertical ...	33 to 18	10 to 100	1·586	2,844	12,470
1½ in., horizontal, with small terminals	47 to 33	1 to 10	1·264	1,178	3,828
Ditto, vertical ...	47 to 33	1 to 10	1·264	1,112	3,611
Ditto, large terminals	47 to 33	1 to 10	1·34	1,690	5,890
1 in., horizontal, with small terminals	47 to 33	1 to 10	1·32	1,567	5,360
Ditto, vertical ...	47 to 33	1 to 10	1·32	1,480	5,060
Tin:—3 in. and upwards, horizontal	43 to 20	1 to 10	1·131	146·6	420·6
Ditto, 6 in. and upwards, horizontal	20 to 7	10 to 80	1·32	239·3	819
Silver:—5 in. and upwards, horizontal	35 to 18	7 to 70	1·287	967	3,210
Aluminium:—4 in. and upwards, horizontal ...	42 to 22	3 to 45	1·461	2,188	8,539
Ditto for critical currents, with spring attachment	42 to 20	2 to 30	1·271	640	2,091

DISCUSSION.

The CHAIRMAN thought a number of points had been brought out on which the majority were in complete ignorance. The fact that a law like that of Sir Wm. Preece had been shown to have an error of 19 per cent. showed the necessity of a paper on the subject.

Mr. ANDREWS said that there was no doubt that fuses were the most unreliable things they had to deal with. He mentioned a case where a transformer was supplied off branch mains fitted with a 70 ampere fuse. A fault occurred on the transformer after working a short time, and although the main fuse (250 amperes) blew, the 70 ampere fuse remained intact. The explanation, he thought, was that the main fuse, which had been working some time, had become warm, whereas the 70-ampere fuse was comparatively cold, the extra rush of current being sufficient to melt the main fuse before the small one. He thought the unreliability of fuses on A.C. circuits was due to the loosening of the lock nuts. It was practically impossible to use fuses on arc lamp circuits; the best thing was to put in a fairly big fuse, and inspect the lamps at short intervals. He was very much surprised that the effect of mechanical injury was not more marked, especially where the wire was almost cut in two.

Mr. COWAN said that not only the carrying capacity, but also the thermal capacity, had to be considered. When a fuse was cold it would do its work all right, but after working five or six hours it was clearly useless to protect motors and generators. He would have liked to hear something about "shunted fuses," which were now coming into use. He would like to know the critical temperature at which a fuse could be run without danger of oxidisation. Lately he had tested a 40-ampere fuse in series with a 1,000-ampere circuit-breaker; the circuit-breaker opened but the fuse did not blow.

Mr. CORMACK said he thought there were fewer factors of unreliability in the open type fuse than in the closed type. He did not think that 100 per cent. excess current should be allowed on all circuits, but one objection to a less percentage was that of lost watts. Automatic circuit-breakers would open nearer the mark, although they sometimes stuck; but where a fuse could be relied on to 50 per cent. or 60 per cent. it was to be preferred to a circuit-breaker.

Mr. BAGGS considered that before long, circuit breakers would replace fuses. Fuses of the damper type for 220 volts need not be 2½ in. in length. In a fuse of that type the mass of molten metal was small, which was a feature of safety. He hoped that manufacturers would not be compelled to make fuses non-interchangeable.

Prof. SCHWARTZ, in replying, said the paper had entailed a very large amount of work. He hoped that it would be of service during the next few years. He thought Mr. Andrews had indicated the right source of trouble with fuses on A.C. circuits. The authors suggested that the current through a fuse should be limited to 100 amperes, and if a larger size were necessary there should be a number of wires in parallel. He could not understand why people wanted to use fuses in oil on D.C. circuits. If for use in collieries, it would be better to break in porcelain. He did not think a fuse would ever be produced to protect a machine from mechanical injury due to a sudden rush of current. With regard to shunted fuses, he thought there was something in them, particularly in breaking large currents on high voltages. The unreliability of fuses was due to three or four things acting together, of which Preece's law was one. He thought that the enclosed type of fuse would come more into use as time went on.

ANNUAL MEETING.

THE annual meeting of the Manchester Section was held on Tuesday evening the 11th inst. in the University, Manchester. The chairman (Mr. C. D. Taite) presided. The secretary in presenting his report, said that 10 meetings had been held during the session, at which there had been an average attendance of 180, against 187 during last year. The present membership of the Section was as follows:—Members, 81; Associate Members, 211; Associates, 166; and 306 Students, making a total of 764. The chairman submitted a resolution from the committee to the effect that in future before any gentleman was nominated for membership of committee, he must have expressed his willingness to stand and be nominated by at least six members, also in the case of nominations for the position of chairman, vice-chairman, or honorary secretary by 10 members.

The CHAIRMAN proposed, and Mr. L. ANDREWS seconded, a vote of thanks to the Council of the University, and Prof. Schuster, for the use of the room for holding the meetings.

Mr. S. L. PEARCE proposed a hearty and sincere vote of thanks to Mr. Taite for his services as chairman during the past session. He thought it had been one of the most successful sessions they had had, and he felt that the meetings could not have been better conducted than by Mr. Taite.

Mr. E. W. COWAN seconded the proposition, which was carried unanimously.

Mr. TAITE, in replying, thanked the meeting for their kind resolution, and said it had been a great pleasure to preside at the meetings, and he felt it an honour to be President of a section numbering about 800 engineers.

Mr. T. L. MILLER proposed a vote of thanks to the honorary secretary (Mr. P. A. Ramage). As one who had held a similar position, he could heartily appreciate the manner in which he had given his services.

Dr. BOWMAN, in seconding the proposal, said that the way in which Mr. Ramage had done his work was eminently satisfactory to all concerned.

The resolution having been carried by the meeting, Mr. Ramage thanked the members for their appreciation of his services. He added that the membership of the section had increased enormously during the time he had filled the post.

The following officers were elected for next session:—Chairman, Mr. S. L. Pearce; vice-chairman, Mr. T. L. Miller; honorary secretary, Mr. P. A. Ramage.

Mr. Julius Frith then read a paper on "Labour-Saving Formula in the Design of D.C. Dynamos."

THE BEST MEANS OF PROTECTING CABLES.

An interesting discussion has been taking place at the recent meetings of the London Section of the Electrical Contractors' Association, and is, we understand, still to be continued.

At the meeting held on March 10th, Mr. Suter referred to the screwed barrel system as an ideal protection, but for many classes of work the cost was prohibitive. He advocated, therefore, what amounts practically to a return to the very earliest method of running cables—namely, to have no protection whatever beyond the actual insulation on the cables. At the last meeting he exhibited samples of bare wires on which blocks of various kinds of cement had been moulded and dried, and showed that with a 500-volt testing set the insulation resistance in some of the samples was very high, the highest being found with roman cement and plaster of paris. Some other samples showed a much lower insulation resistance. He considered, therefore, that what was required was that the cable-makers should provide an insulating material for the conductors which would withstand the action of plaster of paris and the various kinds of cement used in buildings, and at the same time protect the copper conductor from corrosive action.

Most of the speakers who followed, including Messrs. Brightwell, Middleton and Robinson, favoured the draw-in tube system, many of them deeming as unsuitable a system in which the tubes were threaded on to the wires.

Mr. Phipps, on the other hand, thought that the suggestion to run the insulated cable only without protection was better than the tube system, if the insurance companies could be got to agree to it.

Mr. Rawlings described the tinned tube system that has been specified for some time by Messrs. Handcock & Dykes. The speaker claimed to have got very satisfactory results with this system on installations which his firm had carried out.

At the adjourned discussion held on April 14th, several visitors were present by invitation, including Mr. Human of the Guardian Fire Office, together with representatives of the cable and conduit companies, and also several consulting engineers, including Messrs. Hawtayne, Dykes, and Broadbent.

The discussion on this night was confined chiefly to wiring in buildings under construction, that is to say, in skeleton buildings; and whilst the general feeling of the speakers was in favour of a tube system, most of them agreed that it was difficult to prevent trouble arising from condensation.

Mr. Human, from the fire insurance point of view, preferred tubing, because there was less risk of fire in the event of a fault developing, although, he added, he was very sceptical of the usual newspaper statements attributing fires to electrical causes. In his experience electrical fires were very rare indeed. He considered that all tube systems should be provided with outlets or siphons to draw off the water which almost necessarily collected in the pipes.

Mr. Hawtayne also considered draw-in tube systems to be the best for this class of work, that is, for buried work; and for exposed work he thought the Continental system the least unsightly, that is, the system of running twin flexible wires on the walls or ceilings, fixing them up by insulated eyelets.

Mr. Broadbent thought that for a buried system some mechanical protection in the form of piping was essential. He said he thought it was almost impossible to get rid of condensation in a system of this kind because, no matter how well the joints in the pipes themselves might be made, openings occurred at all switchboxes, distributing and sub-distribution boxes, &c., through which moist air could be drawn. This trouble, he thought, could only be prevented by excluding air altogether, which meant practically a solid system. For exposed piping work he preferred to have a clear air space all round the pipes so as to prevent the chilling and resulting condensation which took place when pipes were laid directly on masonry.

Mr. Dykes naturally preferred the system which his firm had developed, of tinned brass tubing of which several samples were shown. He had had very little trouble with this system, and found that installations tested out well after having been erected for many years. The price, he said, worked out to about the same as the screwed barrel system.

One or two speakers, including Mr. Johnson and Mr. Leonard Tate, spoke of the damage to cables which resulted from drawing them into pipes, in some cases the insulation itself being damaged, and in others the wires were ruptured inside the insulation owing to the strain put upon them in dragging them through bends. Part of this damage is caused owing to the twisting and untwisting of the cables consequent upon drawing the wire off coils. These speakers, therefore, thought it would be preferable to thread the tubes on the wires connecting them together by means of running sockets in every case.

Mr. Tate considered that for cheap classes of work, such as residential flats which were wired in course of construction, the mixed system, namely, casing under the floors and piping down the walls, was both good and cheap. He had wired many thousands of lights on this system on about 9s. a point, exclusive of fittings, which price gave a margin of about 1s. 6d. a point profit.

Mr. Rawlings also had leanings towards the mixed system for ordinary house work using compo-tubes splayed out into the casings and boxes.

Some samples of plaster casings were shown by Mr. Clark, who claimed that they were worked as easily as wood casing, and permitted of the wires being sunk into the plaster work without detriment.

The Chairman, Mr. Barry, in summing up the proceedings, referred to the unfairness to electrical contractors of making them responsible for a period of over 12 months for installations, as breakdowns occurred, due to no fault of their own, namely, to the rotting away of the pipe systems laid in cement or plaster. He criticised the so-called drawing-in systems, one of the merits of which was supposed to be that you could draw out any damaged wire. This, he said, was generally impossible, if the wires were rotted inside or any of them had arced over or fused. After all, he said the best system to adopt depended largely upon the conditions, and the common sense of the contractor would have to be used in the future as it had been in the past.

As already mentioned, the discussion is to be again continued, as it was felt that there was still much to be said for and against the various systems in use. The general impression one gathered was, that although the drawing-in tube system appeared to be the popular system at present, yet wood casing still possessed many good points, and many of the installations put down from 10 to 15 years ago on the wood casing system were as good to-day as on the day they were put up, whereas there were very few tube systems which would stand this length of time.

THE CONTINENTAL ELECTRICAL ENGINEERING INDUSTRY.

A Slight Improvement in the Financial Results.

The policy of amalgamation, or extinction, of some of the large works continues to be pursued in Germany. Among the latest projects may be mentioned the decision of the shareholders in the Helios Electricity Co. to liquidate the concern, the manufacturing departments of which are reported to have been acquired—for the sole purpose of shutting down—on joint account by the Berlin Allgemeine Co. and the Siemens-Schuckert Works Co. The closing of the works will naturally remove a competitor from the path of the two large groups in question. Another proposal is, as already mentioned in this journal, the contemplated fusion of the Lahmeyer Co. with the Felten & Guilleaume Co. of Mulheim.

In Belgium the Union Electrique, which is a branch of the Société Générale Belge d'Entreprises Electriques, has amalgamated with the Belgian branch of the Berlin Allgemeine Co. under the title of the A.E.G. Union Electrique. The capital has for this purpose been increased to £80,000, and the consolidation follows as a natural sequence to the fusion of the parent companies in Germany. In addition to this, the Berlin Allgemeine Co. has formed an A.E.G. Roumanian Electricity Co., with a share capital of £50,000, to promote its interests in that part of the Balkans.

German Undertakings.

The Berlin Co. for Electrical Enterprises, which is purely an investment undertaking, had a more satisfactory period in 1904 than in the preceding 12 months on the same amount of share capital, namely, £1,500,000, apart from a bonded debt of £1,750,000. The gross profits reached a total of £195,340 as compared with £153,348 in 1903. Of the former sum the realisation of securities yielded no less than £144,650 as against £29,950 in 1903, whereas the income derived from dividends, interest payments and sundry sources only produced £50,690 as against £123,350 in 1903. The accounts show net profits of £113,400 as contrasted with £61,000, and a dividend is proposed at the rate of 6 per cent. as against 3 per cent. in 1903, and nothing in the preceding 12 months. In the report of the directors it is stated that the whole of the preference shares held in the Anglo-Argentine Tramways Co. have been sold, together with a portion of the ordinary shares in the same company; and other sales include blocks of shares in various tramway companies, in Gans & Co., the Belgian General Co. for Electrical Enterprises, and the Thomson-Houston Mediterranean Co. On the other hand, the investments have been increased in the German Transmarine Electricity Co., the Berliner Telephone Works Co., the A.E.G.-Union Electricity Co., of Vienna, and the Naples Provincial Tramways Co. Among the company's investments the report cites a holding of £37,820 in the British Thomson-Houston Co., and 16,461 ordinary shares and £44,750 "participation" in the Anglo-Argentine Tramways Co.

The accounts of the Bergmann Electricity Works Co., of Berlin, indicate a slight improvement for 1904 over the highly satisfactory results which were attained in the preceding year. According to the directors' report, the company's workshops were extraordinarily well employed during the whole of last year. In the second half the manufacture of glow lamps was commenced, and it was soon possible to increase the production beyond the original estimate. The construction of high-speed dynamos was also undertaken, but in order to obtain satisfactory results from this branch, it has been found necessary to offer turbines in conjunction with the generators,

and the company has, therefore, secured an exclusive license for Germany and other countries for the construction of turbines on the Rateau system, which work is to be commenced in the course of the present year. After writing off £41,000 for depreciation, the accounts show net profits amounting to £97,640, as against £89,920 in 1903, and a dividend has been declared at the rate of 18 per cent., as compared with 17 per cent. in 1903. The capital participating in the distribution is £425,000, but a further issue of £75,000 has been made this year for the purpose of providing additional working funds. The prospects in all departments for the current year are described as favourable, the manufactures invoiced, and the orders received having already exceeded those of the corresponding period of 1904 by 30 per cent.

The shareholders in the South German Cable Works Co., of Mannheim, at the recent general meeting, approved the directors' proposal to pay a dividend of 5 per cent. on £120,000 for 1904 as compared with 4 per cent. in the previous year. In reply to questions, it was officially stated that the current year would, presumably, not be so favourable as 1904, but the prospect existed that an improved demand later on in the year might afford compensation. The accounts for 1904 show net profits of £15,868, as compared with £11,510 in the preceding year, and £6,000 of the former sum has been written off for additional depreciation. The report states that the market conditions later in the year became more difficult owing to the increase in the prices of raw materials, and particularly in the case of copper and rubber, but the prices of manufactures did not advance in a similar manner.

The report for 1904 of the Accumulator and Electricity Works (late W. A. Boese) Co., of Berlin, represents the third year of unprofitable trading, which was preceded by a dividend of 4 per cent. in 1901 and 11 per cent. each in 1900 and 1899. It is pointed out that the absorption of a number of accumulator firms has now turned the competition in stationary batteries into a regular path. The introduction of the Stone train lighting system is making slow but steady progress. The profits on manufacturing were higher than in 1903, but the net result is a deficiency of over £2,400 as compared with losses of £15,500 and £15,800 in the two previous years respectively. As the two latter items were extinguished by drawing upon the reserve fund, and by additional payments made by the shareholders, the loss for 1904 has been carried forward to the next account. The ordinary share capital amounts to £24,200 as a result of the reorganisation undertaken in 1903, while preference shares totalling £201,000 are also in existence. It is now proposed to ask the holders of the former class to consent to the conversion of the ordinary into preference shares on the payment of an additional sum of £25 per share instead of the £20 required when the first offer was made for the transformation. The directors report that an improved demand for batteries has taken place, and more favourable results are consequently anticipated for the present year.

The following is a record of the financial results of certain other German companies in the past two years:—

	Percentage of dividend in 1904.	1903.
Hartmann & Braun, Frankfort	9	8
German Transmarine Electricity Co., Berlin ...	8	6
Max Schorch & Co., Rheydt	7	5
German Atlantic Telegraph Co., Cologne... ...	6	5½
Duisburg Cable Works Co.	6	Nil.
Electricity Co., late H. Poge, Chemnitz	4	Nil.
Paul Meyer & Co., Berlin	4	Nil.
Voltohm Rope and Cable Works Co.	Nil.	Nil.

SWISS AND OTHER COMPANIES.

The Bank for Electrical Enterprises, of Zurich, in which the Berlin Allgemeine Electricity Co. was financially interested last July to the extent of £870,000, has now increased its share capital from £1,320,000 to £1,440,000 by the issue of new shares at the rate of 145 per cent. The new emission has been entirely taken over by the Allgemeine Co. in exchange for the transfer to the bank of all the share capital of the Solingen tramways, and of an interest in another tramway. If the shares had been offered generally to the shareholders in the bank in the proportion stipulated by the statutes, the preponderating influence of the Berlin company would have assured it the right of subscribing for the greater portion of them, and that, too, at a lower premium than that on the basis of which the issue has been carried out.

The position of the Alioth Electricity Co., of Basle, did not materially improve during 1904, notwithstanding the increased turnover, and the delivery of 823 transformers of 22,943 KW., and 1,849 dynamos and motors of a total of 40,530 H.P. The net profits amounted to £19,114, as compared with £13,110 in 1903, the former being arrived at after providing £12,740 for depreciation, or slightly less than in the preceding year, when the entire profits were devoted to this purpose, and the payment of a dividend was out of the question. As the ordinary share capital represents £120,000 and the 6 per cent. preference share capital is also £120,000, the past year's trading has only allowed of the distribution of 5 per cent. on these priority shares, thus leaving the ordinary shares again without any return. The preference shares have just been introduced on the Bourses at Basle and Zurich, where they have been offered at a slight premium.

The shareholders in Brown, Boveri & Co., of Baden, which was formed as a limited company in 1900, and which has since then distributed dividends at the rate of 16 per cent., 5 per cent., 7 per cent., and 9 per cent. in the four years respectively, have sanctioned an increase in the capital from £500,000 to £645,000 by the issue of 2,500 new shares at a high premium, the rate being 165 per cent. It is understood that the additional capital has already been subscribed, seven new shares having been offered for each batch of 25 shares held by existing shareholders. The Swiss company will be remembered as now being closely related to the Berlin Allgemeine Co. which some time ago exchanged shares of £175,000 for shares representing £225,000 in the former company.

Among other Swiss companies may be mentioned the Aluminium Industry Co., of Neuhausen, which proposes to pay 18 per cent. for 1904, as compared with 16 per cent. in the previous year; the Rheinfelden Power Transmission Co. 6½ per cent. as against 6 per cent.; and the Electro-Chemical Works Co., of Bitterfeld, 6½ per cent. on the £275,000 ordinary shares.

The gross profits of the French Thomson-Houston Co. amounted to £172,287 in 1904 as compared with £171,934 in the preceding year. As the yield from investments increased last year, it would seem that the profits on manufacturing operations did not show any improvement, and this is said to have created an unfavourable impression in Stock Exchange circles, as it was declared at the last general meeting that the orders already received were more plentiful than in the whole of 1903. The report of the directors states that the working expenses were less, and the amount required for payment of interest on the bonds was also lower than in 1903. The available surplus is £85,013 as against £84,392 in the preceding year, and a dividend has been declared at the rate of £1 per share for 1904, being the same rate as in 1903.

The Austrian Siemens-Schuckert Works Co., of Vienna, which will be remembered as an amalgamation of the heavy electrical engineering departments of the Siemens & Halske Co., in Vienna, and of the entire undertaking of the Schuckert Co. in that city, recently issued a tardy statement as to the financial results for the first nine months ended with December, 1903. After meeting working expenses, taxes and interest charges, the statement shows a profit balance which has been wholly appropriated for the purpose of depreciation. The fusion is said to have produced satisfactory results, and at the end of 1903, the united company had 3,043 persons in its employment. The number of orders received in 1904 exceeded the combined contracts booked in the preceding year, but no figures are as yet available in regard to the working results for that period.

The report for 1904 of the Allgemeine Austrian Electricity Co., of Vienna, recommends the payment of a dividend of 7 per cent., being the same rate as in 1903; the Felten & Guilleaume Co., of Vienna, has declared a dividend at the rate of 10 per cent., as in the previous year; and the Cable Works Co., of Pressburg, has decided to pay 7 per cent., as in 1903.

REVIEWS.

The Cultivation and Preparation of Para Rubber. By W. H. JOHNSON. London: Crosby Lockwood & Sons. Price 7s. 6d. net.

It is to be feared that little or no connection exists between the cultivators of rubber and those interested in the electrical industry. An intimate knowledge of the trade in rubber, however, makes it clear that if there is no connection, there ought to be one. Undoubtedly, rubber is a most valuable substance for insulating purposes, but in a great measure its place has been taken by other substances on account of its high price. To meet the commercial necessities of the age, the rubber used in some classes of insulation has had to be "extended" out of all recognition. For the last three years the price of rubber has steadily advanced, until now it is selling for 5s. a lb., and shows very little signs of decrease. This is practically double what it could be obtained at a few years ago, and four and a half times as much as rubber once sold for. It would therefore appear that the only possible means of obtaining this valuable insulating substance at a reasonable price, is by encouraging its cultivation.

It is only within the past three or four years that experimental cultivation on a large scale has proved at all successful. Now that all the pioneer work, in finding out the proper conditions that must attend the planting if the undertaking is to be a success, has been done, many others are rushing into the undertaking, and in a few years we shall doubtless find a fair proportion of the rubber used in Great Britain coming from cultivated plantations in our own Colonies. From Ceylon alone last year over 150,000 lb. of rubber was imported into this country, the greater portion of which was of such a superior quality that over 6s. a lb. was obtained. The book under review has been written by the author with a view to giving practical advice to persons taking up rubber cultivation. Mr. Johnson is the Director of Agriculture, Gold Coast Colonies, West Africa, and was commissioned by the Government in 1902 to visit Ceylon for the purpose of studying the methods employed there in

the cultivation and preparation of Para rubber. So far as it goes, the book is practical enough, though scarcely original, partaking more of the nature of a compilation than anything else.

It would be outside the sphere of this journal to go into a detailed criticism of the methods advocated for the cultivation and preparation of rubber, as probably few of our readers are likely to be interested in the subject from a planter's standpoint. The Para rubber tree, which is the favourite one for plantation purposes, takes seven years to arrive at maturity; 200 trees can be planted to the acre, and in the seventh year, if the soil, climate, and proper cultivation methods have been employed, each tree ought to yield 1 lb. of rubber per annum. The total expenses, including superintendence, cost of land, &c., to bring 200 acres of land to the seventh year are calculated at £4,200. Even at 3s. 6d. a lb. obtained for the rubber (and 6s. per lb. is being got at the present moment), it can be seen what a profitable undertaking it is. The plantations in Ceylon, Straits Settlements, and in the East generally, are doing remarkably well, and if Mr. Johnson's book does no more than interest people to invest money in this new industry, and helps in this way to further extend the cultivation of rubber, it will have rendered a service to many industries, not the least of which is the electrical.

Central Electrical Stations: their Design, Organisation and Management. By C. H. Wordingham, A.K.C., M.I.C.E. Second edition. London: Charles Griffin & Co. 1904. Price 24s. net.

It is not every day that one has the opportunity of reviewing so complete and so readable a book dealing with the equipment of central electrical stations. This is not a book to be skipped or lightly read, and, therefore, the delay in issuing our review is excusable. The present edition runs to over 500 pages, has numerous line and photographic illustrations, besides about 80 specimen forms. Perhaps the best way to indicate the scope of the book would be to give the heads of some of the principal chapters—Central Station Work as a Profession—As an Investment—The Establishment of a Central Station—Systems of Supply—Architecture—Systems of Draught and Waste Heat Economy—Coal Handling, Weighing and Storing—The Transmission of Steam—Condensing Appliances—Switching Gear, Instruments and Connections—Distributing Mains—Distributing Networks—Service Mains and Feeders—Meters and Appliances—Standardising and Testing Laboratory—Secondary Batteries—Street Lighting—General Organisation—Mains Department—Drawing Office—Clerical Department.

Central Station Work as a Profession would be almost worth printing separately in pamphlet form, because the author has very definite views on the subject, which some who have drifted from mechanical into electrical engineering have not. The author's advice is:—Leave school at 15 or 16, and go straight to an engineering college for three years. He is distinctly of opinion that the theoretical training should be taken in a large dose before the practical, because he says the learner is then better able to observe and appreciate the small details of practice which would otherwise escape him.

He is also of opinion that the rough surroundings of a workshop, which might be harmful to a mere boy, are comparatively innocuous to a young man. There is much to be said for this, but much depends on the shop and company the boy gets into. Speaking in a general way, present-day conditions in engineering works are a great improvement upon the old days, when the ordeal of "paying one's footing," for example, was not a time to look back upon with any satisfaction.

In the chapter Central Station as an Investment, the author gives it as his opinion that in nearly all important towns a *well-designed and well-operated station* may be expected to yield a profit, and even in small towns and villages it will do so in very many cases. Obviously, everything depends on the italicised words. As matters stand, a large proportion of the smaller stations have not come up to expectation and are causing those interested in them some bad quarters of an hour. The writer's ideas are rather that small towns and certainly all villages would do much better to buy their energy in bulk, and in case no power station is in the neighbourhood, then they should help forward the promotion and establishment of such a station. The committee-room loafing and opposition by jacks-in-office representing small towns and villages is disgraceful, and there is reason to fear that the hands of certain consulting engineers are not quite clean. One expects a barrister to blow hot and cold, as he may be instructed, but expert evidence is, or should be, a plain, unreserved statement of fact. The suppression of material particulars has caused some small towns to lay down little stations which do not, and never can, pay. The bulk of the book is, of course, taken up in discussing various pros and cons connected with boilers, engines, dynamos, steam piping, auxiliary plant, switchgear, and other apparatus which is found inside a central station.

The author has succeeded in a clever and scholarly way in being impartial. Naturally, when he is dealing with small specialities in auxiliary plant he treads on delicate ground, for every inventor and manufacturer thinks his own pet ideas are the best.

It should be noted that this book does not merely deal with the central station building and its contents, but the reader is taken through all the various questions and details connected with feeder systems, distributing networks, street lighting, &c.

The concluding chapters deal with finance and organisation, and here the author has been as successful in presenting essential particulars in a readable way, as when dealing with the machinery portion. Altogether this book should be of the greatest value to the central station assistant.

It only remains to be said that the printing, binding, and the illustrating, have been done in the thoroughly workmanlike manner which characterises Messrs. Griffin's publications.

The Diseases of Electric Machinery. By C. Kinzbrunner. London: Harper & Bros. 1904. Price 1s. 6d. net.

This is an excellent 70-page book by the lecturer on electrical engineering at the School of Technology at Manchester, and it has a unique feature in that the diseases are tabulated on each page into symptom, cause and remedy. It is, therefore, in a form which immediately appeals to the mechanic or handyman who has been given charge of electrical machinery. It, however, goes further than that in the later pages in dealing, in some detail, with alternating current machinery, the arrangement of synchronising lamps for single-phase and three-phase, high pressure circuits, the connections of single-phase motors, &c. As an example of the method adopted, disease No. LXVII. may be cited:—

Symptom.—Speed of compound motor becomes excessive with increasing load.

Cause.—The series winding acts *against* the shunt winding, instead of acting in the same direction.

Remedy.—Reverse the ends of series winding. The series winding is introduced in a compound motor, generally for the purpose of increasing the starting torque, hence it must act in the same direction as the shunt winding. If, however, due to a wrong connection, the series winding acts in opposition to the shunt winding, then, as the load increases, the field will be decreased, with the result that the motor may attain an excessive speed.

Some of the cross referencing is not well done; for instance, under remedy No. XVI., the reader is referred to "Vibration of Machines," but there is apparently no such paragraph, although there are several references to vibration under the heading "Noise."

Photo-Copying Process.—We have received from the "Blue Print" Co., of 128—130, Edmund Street, Birmingham, specimens of their new patent photo-copying process. The chief feature of the prints is the absence of shrinkage; the copies, we are informed, are correct scale drawings, exactly as the original tracing, and from a good tracing the copies are in every way equal to a lithographed drawing, giving a good black line on perfectly clean paper. Copies may be had on drawing paper or linen, or on a great variety of papers to suit all purposes, and they are as permanent as a hand-drawn tracing. We presume that the title of one of the specimens which claims to be one-eighth full size, in contradiction to the printed scale of ½ in. to the foot, must be accepted as a sample of drawing only, and not taken literally.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

3,855A. "Improvements in apparatus for use in starting, stopping and reversing electric motors." E. S. W. Moore and W. B. Bennitt. (Date applied for under Patents, Rule 9, February 24th, 1905.) March 31st.

6,954. "Improvements in electrical prepayment meters." Chamberlain and Hookham, Ltd., and S. H. Holden. April 3rd.

6,958. "Improvements in and relating to safety devices for overhead wires for electric traction and other purposes." H. R. Burnett. April 3rd.

6,969. "An electrical time cut-off for motors and the like." G. Moore and J. H. Hirst. April 3rd.

6,987. "Improvements in electric warp stop-motion mechanism for textile machinery." J. B. Whitney. April 3rd. (Complete.)

6,993. "Improvements in frames for holding electro-glazed glass or prism sections, tile sections and the like." The British Luxfer Prism Syndicate, Ltd., and G. R. Barham. April 3rd. (Complete.)

6,994. "Improvements in and connected with separators for the plates of batteries and the like." W. F. Newcomen. April 3rd.

7,004. "Improvements in electric furnaces." A. Reynolds. April 3rd.

7,008. "Improvements in safety circuit closers." L. Ottinger. April 3rd, (Complete.)

7,010. "Improvements in and relating to methods of receiving electrical impulses." D. W. Troy. (Date applied for under Patents Act, 1901, April 8th, 1901, being date of application in United States.) April 3rd. (Complete.)

7,006. "Improvements relating to the generation of electricity by means of earth cells." E. Jahr. April 3rd. (Complete)

7,019. "Improvements in or relating to electrical contact-breakers." G. Bowron. April 3rd.

7,020. "Improvements in or relating to electrodes for electrolysers used in the manufacture of bleaching liquors." R. Kother. April 3rd. (Complete.)

7,035. "Improvements in and relating to electrical conductors." J. F. Duke. April 3rd.

7,036. "Improvements relating to electrically-propelled vehicles." A. Weiss. April 3rd. (Complete.)

7,048. "Improvements in electric temperature controlling devices." J. E. de Jersey. April 3rd.

7,068. "An improved holder or carrier for the shades of electric lamps." J. Andrews and J. Andrews, jun. April 4th.

7,075. "Electrically-controlled device for operating valves of internal combustion engines." J. A. Main. April 4th.

7,082. "Electrical alarm mat." J. Skinner. April 4th.

7,095. "Improvements in arc lamps." J. M. Wellington and W. F. Daniell. April 4th.

7,101. "Apparatus for absorbing gases by a liquid under the action of the silent electric discharge." A. De Hemptinne. April 4th. (Complete.)

7,105. "Improvements in electrical cables." W. T. Henley's Telegraph Works Co., Ltd., and H. Savage. April 4th.

7,111. "Improvements in or connected with magneto-electric generators." L. A. Gianoli and R. A. Persin. (Date applied for under Patents Act, 1901, April 14th, 1904, being date of application in France.) April 4th. (Complete.)

7,115. "Improvements in combined engine and generator." D. M. Small. April 4th. (Complete.)

7,121. "New or improved means of attaching the globes of electric arc lamps." H. Baggett and The New Century Arc Light Co., Ltd. April 4th.

7,124. "An improved telephone system." W. P. Thompson. (A. S. Elektrisk, Bureau, Norway.) April 4th.

7,133. "Improved electric regenerative battery." W. H. Fellows, E. T. Pickup and W. Tice. April 4th.

7,136. "Improvements in the electric lighting of trains." H. Leitner and R. N. Lucas. April 4th.

7,148. "Improvements in and relating to electric motor control systems applicable for electrically propelled trams or vehicles." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 4th.

7,149. "Improvements in and relating to electric motor control systems applicable for electrically propelled trams or vehicles." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 4th.

7,150. "Improvements in and relating to systems of electric motor control applicable for electrically propelled trams or vehicles." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 4th.

7,157. "Improvements in or connected with the regenerative control of electrically propelled vehicles." H. W. Dickinson. April 5th.

7,159. "Improvements in telephone apparatus." B. Ehrlich and M. Konrad. April 5th. (Complete.)

7,176. "Improved method of operating the points of overhead trolley wires and also of the rails for electric tramways." J. Greenwood & Son. April 5th.

7,197. "An electric current reversing switch lamp socket and plug combined." H. R. E. Perkins and J. Blakey. April 5th. (Complete.)

7,204. "Improvements in and relating to induction motors." W. G. Strang. April 5th.

7,211. "Improvements in or relating to electric clocks." H. A. Campiche. April 5th. (Complete.)

7,277. "An improved case and cover for fire alarms, electric bell calls and the like." J. H. Golding. April 6th.

7,295. "Improvements in or relating to alternating current electric motors." B. G. Lamme. (Date applied for under Patents Act, 1901, May 3rd, 1904, being date of application in United States.) April 6th. (Complete.)

7,302. "Improvements in and connected with sound boxes for phonographs, gramophones, telephones and the like." C. A. Mulder. April 6th.

7,304. "Improvements in electrically operated burglar and like alarms." T. W. Senier and J. G. Farquhar. April 6th.

7,350. "Electro-mechanical tenter hook detector." W. Hemingway, A. Silcock and C. B. Hogg. April 7th.

7,359. "A device for automatically regulating the resistance on a switchboard for electrically-driven machine or lights in conjunction with the governor of the engine." J. Lamb and O. T. Newton. April 7th.

7,360. "An improved device for keeping the trolley rope of an electric car tight, when the boom is in various positions." J. L. Dawson, J. Clark and R. Blackmore. April 7th.

7,405. "Improvements in contact devices for electric switches." The Elektrizitats-Actien-Gesellschaft vorm W. Lahmeyer & Co. (Date applied for under Patents Act, 1901, May 9th, 1904, being date of application in Germany.) April 7th. (Complete.)

7,416. "Improvements in vapour electric apparatus." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 7th.

7,418. "Improvements in relays for electric circuits." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 7th.

7,419. "Improvements in and relating to signalling systems." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 7th.

7,420 "Improvements in electric systems for controlling guns and the like." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 7th.

7,421. "Improvements in and relating to electrically driven vehicles." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 7th.

7,433. "Improvements in automatic motive power by electricity." W. N. L. Davidson. April 8th.

7,438. "Improved method of securing the removable cover of a tumbler or like electrical switch." E. T. Davies. April 8th. (Complete.)

7,443. "Apparatus for recording the time in which a current has been flowing in an electrical circuit." Kelvin & James White, Ltd., and J. Menmuir. April 8th.

7,444. "Improvements in or connected with electric lamps, particularly applicable to the tail lamps of motor-vehicles." J. W. Greenwood. April 8th.

7,449. "Improvements in electro-magnetic or eddy current brakes and electro-magnetic clutches." D. K. Morris and G. A. Lister. April 8th.

7,492. "Improvements in air-insulated telephone and telegraph cables." E. Jensen. (Date applied for under Patents Act, 1901, April 9th, 1904, being date of application in Denmark.) April 8th. (Complete.)

7,508. "Improvements in telephone transmitters." H. M. Gail. April 8th. (Complete.)

7,584. "Improvements in and relating to heating by electricity." F. Wynne. April 10th.

7,591. "Improvements in connection with alternating current machines for synchronising and connecting them with distributing conductors." J. Y. Johnson. April 10th.

7,595. "Improvements in means or apparatus suitable for indicating leakage of electricity." J. F. Driver. April 10th.

7,596. "Improvements in or relating to apparatus for supplying alternating electric currents." A. F. Berry. April 10th.

7,601. "A signalling device for indicating alteration of speed of self-propelled vehicles." M. Kennedy. April 10th.

7,605. "Improvements in collecting devices for dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 10th.

7,606. "Improvements in and relating to electro-magnetic switches." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 10th.

7,617. "Improvements in electric cut-out switches." J. Frechette. April 10th. (Complete.)

7,645. "Improvements in electrical transformers and the like." G. Hanchett. April 11th.

7,700 "Improvements in magneto-electric machines." E. B. Gray. April 11th.

7,719. "Improvements in means for regulating variable speed dynamos." H. Leitner and R. N. Lucas. April 11th.

7,720. "Improvements in the manufacture of electric accumulators." H. Leitner. April 11th.

7,721. "Improvements relating to electric single-phase motors." The Phœnix Dynamo Manufacturing Co., Ltd., and W. Oelschlager. April 11th.

7,732. "New or improved means for electrically indicating and recording at a distance changes in level of liquid in reservoirs, and for giving warning of any prearranged maximum or minimum level." P. V. Vaudrey. April 11th. (Date applied for under Patents Act, 1901, April 11th, 1904, being date of application in France.) (Complete.)

7,814. "Improvements in appliances for lighting gas lamps and the like by electricity." W. P. Thompson. (O. Freudenthal, Belgium.) April 12th.

7,822. "Improvements in systems of control for electric motors and apparatus therefor." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 12th.

7,828. "An electrical signalling device for motor-cars and other vehicles and for other purposes, available for night and day use." W. E. Williams. April 12th.

7,842. "Improvements in flexible armoured electric cables." W. C. Johnson and S. Paterson. April 12th.

7,843. "Improvements in electric arc lamps." L. Galas. April 12th.

7,853. "Improvements in or connected with electrically propelled railway vehicles or locomotives." J. P. Barker. April 13th.

7,872. "Improvements in magneto ignition devices." E. R. Clarke. April 13th.

7,874. "Improvements in and relating to apparatus for the control of electric circuit breakers and like devices." L. Andrews. April 13th. (Complete.)

7,879. "Improvements relating to trolley-heads in connection with overhead electric transmission." J. W. Hancock. April 13th.

7,892. "Improvements in vapour electric apparatus." P. H. Thomas. April 13th. (Date applied for under Patents Act, 1901, April 14th, 1904, being date of application in United States.) (Complete.)

7,903. "Improvements in electric accumulators for secondary electrolytic cells." W. Fennell and W. P. Perry. April 13th.

7,919. "Improvements in and relating to electric rheostats." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 13th.

7,920. "Improvements in electric switches." S. O. Cowper-Coles. April 13th.

7,937. "Improvements relating to adjustable brackets or arms for supporting electric lights or the like, and applicable also to brackets or supports for other purposes." W. H. Pick. April 14th.

7,956. "Improvements in lifeguards for electrically-propelled vehicles and the like." E. A. Greaves. April 14th.

7,973. "Improvements in or relating to electrical regulating, testing and measuring apparatus." R. W. Paul and G. W. Harris. April 14th.

7,994. "Improvements in and relating to mercury-vapour lamps." H. V. Siim-Jensen. (Date applied for under Patents Act, 1901, June 18th, 1904, being date of application in Denmark.) April 14th. (Complete.)

8,002. "Improved construction of apparatus for winding coils and bobbins for electrical and other purposes." H. Bourne. April 14th.

8,026. "Improvements in starting devices for alternating current dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 14th.

8,028. "Improvements in electric motor controlling switches." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) April 14th.

8,033. "Improvements in terminals and connections for electric wires." A. J. Downes. April 14th.

8,049. "Improvements in and relating to the working of electric or other tramway or railway points." W. B. Docharty. April 15th.

8,051. "Improvements in and relating to electrical circuit-breakers." Veritys, Ltd. April 15th.

8,071. "Improvements in automatic electric circuit-breakers." J. E. Spagnoletti. April 15th.

8,087. "Improvements in and connected with disc speaking apparatus." W. Taggesell. April 15th. (Complete.)

8,090. "Improvements in and relating to trolleys for electric railways and the like." A. P. Zani. April 15th. (Complete.)

8,095. "Improvements in and relating to electric switch mechanism." The British Thomson-Houston Co., Ltd., and F. Holden. April 15th.